Implementation of Individual System Qualification (ISQ) in a CBRN Respiratory Protection Program, Part B: Standard Operating Procedures

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In conducting the research described in this report, the investigators adhered to the policies and procedures set out in the Tri-Council Policy Statement: Ethical conduct for research involving humans, National Council on Ethics in Human Research, Ottawa, 1998 as issued jointly by the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council of Canada.

Abstract

Protection of first responders (FRs) during a chemical, biological, radiological, and nuclear (CBRN) event involves a well-integrated approach by all levels of the government. The standard CAN/CGSB/CSA-Z1610-11 *Protection of First Responders from Chemical, Biological, Radiological, and Nuclear (CBRN) events* provides a risk-based guidance to first responders and management regarding protection during a CBRN event. Part A of this report outlined the strategies and performance criteria to ensure the successful implementation of an individual system qualification (ISQ) respiratory protection program for first responders in a CBRN event, a mandatory part of the standard CSA Z1610-11. The objectives listed below are addressed in this report to support implementation of methodologies for an adequate ISQ program with compliance to best practices recommended in the standard CAN/CGSB/CSA-Z1610-11. Several stakeholders, including the Royal Military College, participated in optimizing the recommended procedure for knowledge transfer and implementation to different organisations. These objectives are as follows:

- Educate first responders on proper use of respiratory protection programs, donning of respirators, sizing, doffing, maintenance through standard operating procedures and compliance with standards Z1610-11.
- Disseminate technical knowledge to managers and trainers of first responders interested in written respiratory protection programs (RPP) based on Z1610-11 for CBRN respirators. Prepare and provide standard operating procedures, which standardize user instructions and training as per stakeholder's interest.

The implementations of an ISQ from CAN/CGSB/CSA-Z1610-11 in all jurisdictions will ensure efficacy and safety for all FR responding to a potential CBRN event.

Résumé

La protection des premiers intervenants (PI) en cas d'incident chimique, biologique, radiologique ou nucléaire (CBRN) nécessite une démarche bien intégrée à tous les niveaux du gouvernement. La norme CAN/CGSB/CSA-Z1610-11 *Protection des premiers intervenants en cas d'incidents chimiques, biologiques, radiologiques et nucléaires (CBRN)*, fournit aux premiers intervenants et aux gestionnaires une orientation fondée sur le degré de risque en matière de protection en cas d'incident CBRN. Partie A de ce rapport donne un aperçu des stratégies et des critères de rendement visant à assurer la réussite de la mise en œuvre d'un programme de qualification des systèmes individuels de protection respiratoire pour les premiers intervenants en cas d'incident CBRN. Il s'agit là d'un volet essentiel de la norme CSA Z1610-11. Le rapport traite des objectifs ci-dessous afin d'appuyer la mise en œuvre de méthodologies pour un programme de qualification des systèmes individuels adéquat et conforme aux pratiques exemplaires recommandées dans la norme CAN/CGSB/CSA-Z1610-11. Plusieurs intervenants, dont le Collège militaire royal, ont joué un rôle dans l'optimisation de la procédure recommandée pour le transfert des connaissances et la mise en application dans différentes organisations. Voici les objectifs en question:

- Former les premiers intervenants en matière d'application des programmes de protection respiratoire, d'utilisation des appareils respiratoires ainsi que d'ajustement, d'enlèvement et d'entretien de ces appareils en fonction des instructions permanentes d'opération et de la norme Z1610-11.
- Communiquer les connaissances techniques aux gestionnaires et aux formateurs de premiers intervenants qui s'intéressent aux programmes de protection respiratoire rédigés à partir de la norme Z1610-11 sur les appareils respiratoires CBRN. Préparer et diffuser les instructions permanentes d'opération qui serviront à uniformiser les instructions d'utilisation et les formations en fonction des intérêts des intervenants (partie B).

La mise en œuvre d'un programme de qualification des systèmes individuels fondé sur la norme CAN/CGSB/CSA-Z1610-11 dans toutes les sphères de compétence assurera l'efficacité des opérations et la sécurité de tous les premiers intervenants en cas d'incident CBRN.

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1. Scope

The purpose of this manual, which is a supplement to Part A of this report [1], is to provide chemical, biological, radiological and nuclear (CBRN) first responders (FRs) with the proper guidance to implement individual system qualification (ISQ) procedures within a respiratory protection program (RPP). This manual describes the recommended practices, procedures, and equipment necessary for conducting ISQ when the respiratory protective device (RPD) is an air-purifying respirator (APR), powered air-purifying respirator (PAPR) or self-contained breathing apparatus (SCBA).

2. Background

Individual System Qualification describes the set of practices and procedures necessary to qualify an individual to use a pre-qualified CBRN personal protective system, consisting of a respiratory protective device, dermal protective equipment (DPE) and any other relevant personal protective equipment (PPE) (e.g. corrective eyewear, helmet, body armour, etc.). The ISQ involves the steps displayed in the following flowchart (Figure 1), whereby a "pass" for each component is required to qualify the RPD for use.

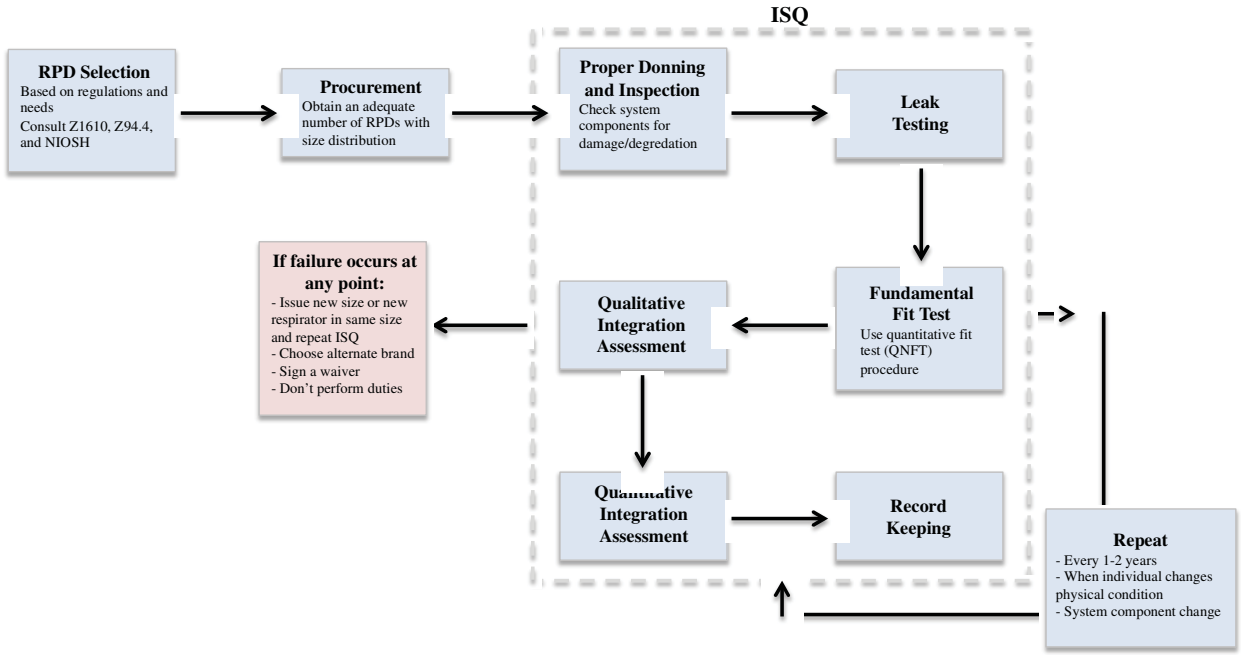

Figure 1: Individual system qualification steps for the validation of a respiratory protection device integrated with appropriate personal protection equipment

The different components of an ISQ involve the following steps;

- proper donning and inspection,
- leak testing,
- fundamental fit testing,
- qualitative integration assessment,
- quantitative integration assessment, and
- record-keeping.

The procedures for implementing these different components will be covered in detail throughout this document, providing a first responder organisation the tools to successfully implement an ISQ program. The procedures as outlined are examples showing the level of detail that should be in place for an

organisation's ISQ process, and use the PC4 respirator[1], a commonly used CBRN respirator in Canada by numerous first responder groups. For many of the ISQ components, other masks such as the C50[2] could use similar procedures to the PC4, however the information must be customised based on manufacturer information and the organisation's own experiences and requirements.

[1] Manufactured by Airboss Defense, Bromont, Quebec, Canada.

[2] Manufactured by Avon Protection

3. Materials and equipment

The following items below are recommended for conducting ISQ assessments.

1. All sizes of RPDs, DPE, and other personal equipment/gear, as appropriate, that have been previously qualified at the systems level (the test candidates may bring their own system components, but spare components of different sizes are likely to be needed for correcting of sizing and integration issues, as well as to replace defective masks).

2. Sizing charts/kits for the RPD, DPE (and other relevant personal equipment) if available, and the necessary tools for their application (e.g. cloth tape-measure, respirator sizing tools).

3. Antiseptic-type wipes for cleaning respirator facepieces.

4. A respirator leak tester. One example suitable for the PC4 is the Maintenance Leak Tester and accessories (Section 4.5), including canister-mount plug, maintenance tools (e.g. torque wrench, if relevant), spray bottle containing clean water, and roll of paper towel. Another example is the Mask Integration Test Accessory (Section 4.6).

5. TSI particle generators (Annex A), model 8026 (minimum of 2 generators per 2 person tent) and accessories, including reservoir, power cable, salt tablets, mortar, pestle and clean water if unavailable at the test site (approx. 250 mL per generator per day).

6. Tent or other suitable enclosure (Annex B), suitable for standing, bending, and performing small jumps in full gear (including helmet, if applicable) for at least 1 test candidate. Typically, space for 2 or more test candidates is preferred (air-tight design with sampling port (hole), a window suitable for visual communication, ± 8 foot high flat or low sloping roof, and lateral dimensions of approximately 4 by 6 feet, for a single test area).

7. Tent accessories, if relevant (e.g. sand bags to replace pegs for indoor use, duct tape or ChemTape®[3] to seal closures, etc.).

8. Two to three tables and chairs for stations for leak testing, Quantitative fit test (QNFT), and Quantitative integration fit test (QNIFT).

9. Small platform or table to support a PortaCount® inside the tent, if necessary, for the combined standing and kneeling activities during a quantitative integration fit test (however, with a well-positioned sampling port, it will be possible to test from outside the tent).

10. PortaCount®(s) – preloaded with test protocols and test candidate database, as applicable (see Annex C for model 8020 procedures and Annex E for 8030/8038 procedures).

11. PortaCount® accessories, including power cables, computer cables (if applicable), twin tubing, HEPA filter(s), alcohol wick cartridge, alcohol fill capsule, clean wicks, reagent grade isopropyl alcohol, drinking tube adaptor(s), drinking tube clean-out tool (e.g. syringe with adapter) and a can of compressed air.

12. Computer and computer accessories, as needed for use with the PortaCount® (software required) and/or for record-keeping.

[3] Kappler, http://www.kappler.com/index.php/products/accessories.

13. Low dust particulate filtering canisters (minimum 2) with Ultra Efficiency Particulate Air (ULPA) filters (efficiency >99.997%) compatible with the RPDs and other system elements (e.g. helmet);

14. Portable air-conditioner/dehumidifier and/or heater, if necessary to maintain the tent temperature at 24 ± 3°C and relative humidity below 60% (this is unlikely to be required if testing is to be performed in an air-conditioned building).

15. Extension cords and power bars (of sufficient length and number to service the PortaCount®(s), computer(s), particle generators, and air conditioner).

16. Thermometer and humidity sensor.

17. Any modified components necessary to complete the fit testing, including modified facepieces, if necessary. Examples include:

    a. facepieces that are probed or otherwise adapted for fit-testing, if they lack a drinking tube or other appropriate means of sampling inside the mask; and

    b. facepieces or PAPR blower tubing that are modified to accept a particulate filtering canister. Note that PAPRs are to be tested in negative pressure mode, as particles released from the blower (and secondarily from blower tubing) may interfere with the fit test. Typically, the tubing can be disconnected from the facepiece, and replaced with a canister installed directly into inlet mount (i.e. without modifications). Alternatively, the PAPR can be tested with the blower attached but turned off.

18. Pre-established record-keeping system and consent forms, if relevant.

4. Instructions

4.1 Respirators

A respiratory protective device needs to offer long-lasting, competent protection to the face, eyes, respiratory and gastro-intestinal tract. In a CBRN event, this requirement is more stringent due to the feasible worst-case scenarios, which may present high concentrations of chemical, biological, and/or radioactive particles.

CSA Z1610 recommends five types of RPDs be used for multi-hazard or particulate protection, all yielding a minimum level of protection of less than 0.01% of total inward leakage (protection factor (PF) of 10,000) evaluated using a simulated workplace protection factor (SWPF) method [1]. The RPD types are listed below:

- self-contained breathing apparatus (SCBA);
- air-purifying respirators (APRs) for multi-hazard protection;
- APRs for particulate filtration only;
- powered air-purifying respirators (PAPRs) for multi-hazard protection; and
- PAPRs for particulate filtration only.

Less than 0.01% total inward leakage (PF of 10,000) is recommended in the standard as the minimum acceptable requirement for an RPD to be used outside the hot zone (any of the above depending on the event). A minimum PF of 20,000 (total inward leakage of 0.005%) provided by an SCBA (all-hazards) or APR or PAPR (particulate protection for a particulate event only), along with a limited time of exposure, is recommended for hot zone response [1].

4.1.1 Selection of appropriate canister for fit-testing

In most cases, the canister(s) of the same type that will be supplied for use with the RPD can be used for fit-testing. However, there are circumstances where this may not be the case, as outlined following:

- A fit-testing facepiece for an SCBA is usually used, in which case the manufacturer will supply an appropriate filter (note that its filtration capabilities may not need to be particularly high since the requirement is a PF of 500 [2] or 1,000 [3] in negative-pressure mode;
- The supplied canister produces too much particulate that interferes with the measurement (note that such a canister is not desirable for use in general);
- A less expensive particulate-only fit-testing canister is desirable if many fit tests are to be performed.

The administrator or their delegate responsible for the ISQ must be able to select a canister for ISQ and assure that it delivers the necessary performance, in order for ISQ results to be appropriate and successful.

Some of the factors to be considered are the weight, breathing resistance and geometry of the canister (so that realistic results will be obtained), the particulate filtration efficiency, and possible particulate generation by the canister. For example, the weight, breathing resistance and geometry of a less expensive particulate-only canister can be increased to match those of a CBRN canister in use through the application of various custom-made adapters; however the organization must have the capability to have these parameters evaluated and matched.

4.1.2 Air-purifying (APR) and powered air-purifying (PAPR) respirators

The inspection prior to use for sizing/fit testing may be done locally (within the organisation) for an APR, while servicing can be either done locally or be conducted by an outside organisation. Outside servicing of the blower on a PAPR is usually required unless a trained technician is on staff, although a local inspection may be performed to identify obvious problems.

If a RPD is personally issued, then the wearer should preferably have their ISQ performed with that same mask, otherwise the ISQ is only a test to determine a user's mask size for future use. No special modifications should be needed for testing. PAPRs can be fit tested as an APR (i.e. take off the hose that leads to the blower and replace with a fit-test canister) or, alternately, as a PAPR with the blower attached but turned off.

The pass/fail values under Z1610 for the fit testing are 10,000 or 20,000, depending on the intended use, for either APR or PAPR.

Qualitative integration assessment is performed with an APR or full PAPR system combined with full PPE. The quantitative integration fit test (QNIFT) should be performed also.

4.1.3 Self-contained breathing apparatus (SCBA)

In order to maintain device approvals, there is minimal inspection or servicing that can be performed locally on an SCBA without having a fully trained technician on staff.

When fit tested for a SCBA, a special fit testing mask must be used (except for a dual mode respirator system which combines an APR/PAPR with an SCBA, and contains a drinking tube that permits connection for QNFT). Although the SCBA is always in positive pressure, during the fit test the mask is in negative pressure mode, which cannot be achieved with the SCBA mask itself. A modified facepiece is used that contains a connector for the PortaCount®, a location for a canister, and no airline connection. The pass/fail value for the SCBA fit test mask is a PF of 500 in Z1610-11 [2][4] and 1,000 in Z94.4-11 [3]. Protection factors of >20,000 in positive pressure mode can be successfully achieved even though the PF is only 500 in negative pressure mode [4].

4.2 PPE size selection

Respirators that are poorly sized for an individual are unlikely to provide the necessary face seal to ensure high protection factors. Poorly sized suits may cause integration issues, causing the respirator to leak e.g. by pulling on the respirator during certain activities/movements. Attention to proper sizing and integration of other PPE, such as helmets, is also important for similar reasons. To successfully implement an ISQ program to protect a variety of FRs for a CBRN event, the following guidelines regarding PPE should be followed:

1. have available all sizes and models of RPD, DPE, and other relevant PPE;
2. follow manufacturer sizing guidelines, including sizing charts/kits, where available; and
3. follow other sizing recommendations, including the following:
    a. for RPD:

[4] Likely to be modified in future editions to match Z94.4-11.

4. If other methods are unavailable or impractical, the simplest sizing method will be to don the different sizes, usually starting with a medium, which fits a majority of users.

5. After tightening the respirator, assess for a full seal around the entire face and under the chin, and observe that the hairline is outside the area of the seal (if possible).

6. Ask the user to move their head up-down and side-to-side, and then flex their facial muscles (e.g. grimace) while observing for breaks in the seal. Have the user perform a negative pressure seal check.

7. Ask the user to assess the comfort of the respirator. If it is uncomfortable, then try other sizes and/or qualified models, repeating step (ii) and (iii), above. Alternatively, if the pre-qualified system allows for changing of the nose-cup (by properly trained personnel), then this provides another option for improving the comfort. For example, if an individual requires a small or extra-small mask (because of a long face) but has a large nose, then a medium or large nose-cup installed into a smaller mask can increase the user's comfort.

   a. and for DPE:

8. Have sizing charts and data available for a number of protective ensembles.

9. In the absence of sizing guidelines, the user can estimate their DPE based on their personal experience with other similar clothing.

10. User tries on the DPE, fitter assesses for unanticipated gaps/openings.

11. User assesses for comfort during simple movements (bending, crouching, arms up and down, head side-to-side and up-down.). The DPE material should move fairly freely.

4.3 Methods for assessing RPD leakage and protective performance

In general, methods that can detect whether a respirator is providing adequate protection against leakage fall into two categories, qualitative and quantitative (protection factor measurement) methods. The protection factor is a measure of the factor by which protection is improved when wearing the respirator based on leakage into the system and is calculated for each activity. The PF for a given activity is obtained as outlined in Equation (1):

$$PF = \frac{C_b + C_a}{C_r} \tag{1}$$

where C_b and C_a are the challenge particle concentration before and after sampling the respirator and C_r is the particle concentration in the respirator measured in between (measured using the same particle counter that switches back and forth). The cumulative or overall PF is calculated over the n-minute activity routine, where n is the number of 1 minute activities, as defined in Equation (2):

$$Overall\ PF = \frac{n}{\frac{1}{PF_1} + \frac{1}{PF_2} + \frac{1}{PF_n}} \tag{2}$$

4.3.1 Qualitative versus quantitative fit testing

Fit testing involves either a qualitative or quantitative assessment of the adequacy of a RPD fit by measuring or acknowledging the inward leakage of a representative airborne material into the respirator [4]. Qualitative fit testing (QLFT) is a simple pass/fail procedure that is based on the subjective reaction of an individual to a scented or irritant product. This method is not sensitive enough to measure the high PFs needed for CBRN events, and is not recommended for CBRN fit-testing activities [2], but it can be conducted quickly and immediately prior to a response, revealing problems that significantly reduce protection, e.g., stuck valves, cold facepieces and facial hair trapped in a seal [4]. Quantitative fit testing (QNFT) is used to quantify a specific PF value for an RPD and is necessary for validating the high PF values needed for CBRN events.

Condensation nucleus counting (CNC) and other particulate measurement methods are used for quantitative fit testing to validate RPD and PPE against such standards as CAN/CGSB/CSA Z1610-11 [2]. It is important to recognise that CNC-based methods are susceptible to artifacts arising from background particulate generation from the respiratory tract as well as from blowers or supply air [4][5][6]; these artifacts make protection seem lower than actual by overestimating the within mask particle count. Such background particulate generation can result from eating, drinking, coughing, smoking, blower contamination, or even if the test participant has been involved in strenuous exercise prior to testing. Procedures were developed under CRTI Project 06-0192TD [4] to minimize the effects of spurious particles when using CNC to measure high PFs, and will be discussed in Section 4.8.

Other factors, which can lead to lower PF results, are leakage from around the face seal usually due to an ill-fitting mask, and leakage through other components such as the filter and exhalation valve.

4.4 Component inspection

Inspect the system components (whether new or used) for signs of damage or degradation, as follows.

4.4.1 RPD

- Inspect the facepiece for tears, cracks, holes, loss of flexibility and discoloration.
- Inspect for distorted seal surfaces.
- Inspect the integrity of the harness, straps and buckles and test for adjustability.
- Ensure that inhalation and exhalation valves are present and seated properly.
- Examine the valves for cleanliness and remove any grit or dirt/film or replace the valve if necessary.
- Examine the valves for deterioration such as tears/holes, folds/excessive curls, corrosion/pitting, and lack of pliability.
- Examine the valve supports and canister mount for cracks and holes.
- Inspect the speech transmitter(s) for damage and tighten with a torque wrench, if applicable.
- Inspect the facepiece lens for scratches, cracks and gouges that would reduce the visibility and impact resistance.
- For PAPRs, inspect the hoses for cracks and holes.
- Inspect hose connections for general integrity and ensure that they are tight and secure.

- Inspect PAPR helmet or hood for damage, and for missing or dislocated padding, if applicable.
- Check the PAPR airflow following the user manual instructions.

4.4.2 DPE

- Hold garments up to the light and examine for cuts, tears and holes.
- Examine for damaged seams.
- Inspect for malfunctioning closures.
- Flex the garment and observe for cracks or other deterioration.
- Examine for UV- or chemical-induced deterioration based on discoloration, stiffness, softening or swelling.
- Perform a vapour-tight integrity test for a totally-encapsulating system [7].

If problems are identified during the component inspection, then the item is to be tagged, removed from service, and replaced with a working equivalent. It is necessary to confirm that proper storage procedures are followed, and PPE must be stored in a manner that will protect against dust, sunlight, extreme heat or cold, excessive moisture, vermin, and damaging chemicals. Respirators must also be stored in a manner that will protect against deformation and damage from impacts. Storing in a neutral position and/or on a face-form may minimize deformation. Impact damage can be prevented by storage within a hard-shelled case or cabinet.

4.5 Leak testing using the Maintenance Leak Tester

An ISQ can only be successful if the mask is intact and leak-free; therefore it can be convenient to check performance of an individual mask prior to starting QNFT. The Canadian Forces Maintenance Leak Tester (CFMLT)[5] is currently in use by the Canadian Armed Forces (CAF). Although designed specifically for the C4 mask[1] (the military version of the PC4), it was found that the CFMLT could be successfully used to leak test the PC4, and most other first responder masks, in all sizes.

The leak tester contains a pressure system to pressurize the face-form seal, as well as a vacuum system to pull the air out of the mask in order to test the quality of its seal against the face-form (i.e. negative pressure test). The tester operates it by donning the mask onto a headform, sealing the relevant ports, and creating a negative pressure inside the mask. A pressure gauge monitors the mask's ability to maintain the pressure in a specified range over a measured period of time. The procedures for leak testing with the CFMLT are given below.

4.5.1 Set-Up of the leak Tester

1. Set the leak tester on a level surface at a height comfortable to the user with the larger part of the case (the lid) on top.
2. Remove the lid of the leak tester.
3. Remove atomizer (spray bottle) from its location and fill with clean water.

[5] Manufactured by Odim Numet (www.odimnumet.com)

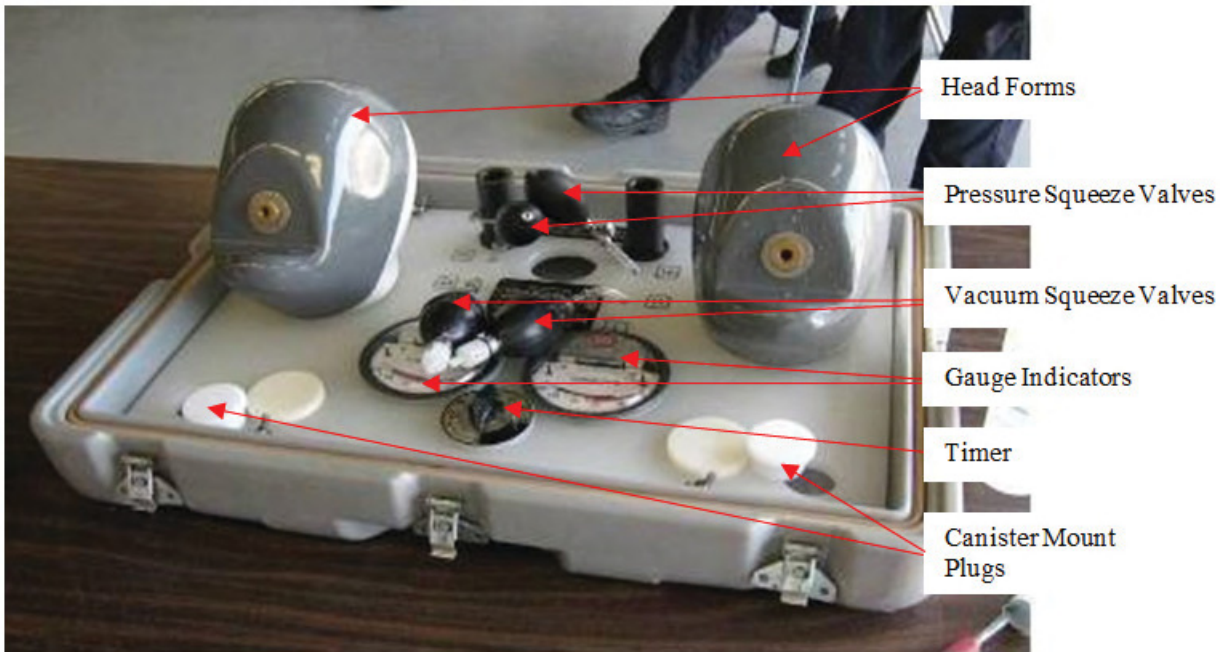

Figure 2: Maintenance Leak Tester top panel controls (note that new leak tester looks slightly different)

a. Inspect all parts shown in Figure 2 by the following procedure, below.

b. Visually examine all bulbs, tubing, and face-form material for evidence of damage. The material should be smooth and pliable and should not show evidence of fraying, crimping, or cuts.

c. Slightly open all bleed valves.

d. Ensure that both vacuum gauges indicate zero.

4. If the gauge indicator does not read zero, adjust by turning the small screw at 6 o'clock on the pressure gauge crystal (Figure 3). Once this has been set, it should never need re-setting unless it has been tampered with or is faulty.

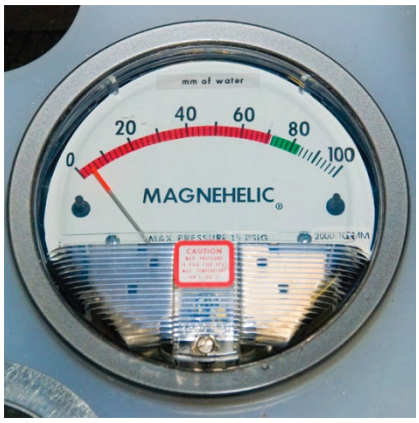

Figure 3: Pressure indicator gauge

a. Close the bleed valve on the pressure bulb on the side that is being tested (P1 or P2).

b. Inflate the face-form with 4 or 5 pumps.

c. Visually monitor the inflation of the face-form sealing surface (Figure 4) for several minutes to ensure that no leakage has occurred.

d. Slightly open the pressure bleed valve; the face-form should deflate rapidly.

Figure 4: Face-form deflated (left) and inflated (right)

e. Close vacuum bleed valve (V1 or V2) on the side that is being tested.

f. Plug the threaded hole in the face-form with a wetted finger.

g. Gently pump the vacuum bulb enough to bring the gauge indicator top of the green gauge range (greater negative pressure) – open the bleed valve slightly if the vacuum is too large.

h. Monitor the gauge indicator for 45 seconds or more to ensure that the needle does not move i.e. no discernible leakage is occurring. (The timer may be used to indicate the minimum time).

i. Slightly open the bleed valve; the gauge indicator should drop to zero.

5. If the leak tester does not pass the tests, follow instructions in manual.

6. If unable to remedy the problem, contact the manufacturer for further troubleshooting instructions.

4.5.2 Leak testing procedure

1. Clean the mask to be tested if necessary: inspect for dust/grit on sealing surfaces such as valves, valve seats, and the face-seal.

2. Spray the face-form with water, this simulates sweat and ensures a better sealing surface. It may also help to dampen the face-seal of the mask. Avoid excess water on the rest of the unit, as excessive moisture may damage parts (timer and pressure gauges).

a. If possible, dampen the exhalation valve of the mask by spraying with water and running a finger around the edge. This simulates moisture from breath and creates a better seal.

3. If the mask does not have NATO thread for the canister mount plug but has a sealing mechanism (valve, etc.) over the inhalation valve(s), ensure that the mechanism is functioning properly and wetted if necessary.

4. To mount the mask on the face-form, fold the harness over the front of the mask. Insert the chin of the face-form into the chin cup and tilt the mask onto the face-form. Holding the mask in place with one hand, pull the harness over the head of the form and tighten the harness straps (Figure 5). Do not over-tighten.

NOTE: Depending on the size and model of respirator, the nose-cup of the mask may not completely cover the threaded hole in the face-form. Provided the nose-cup is not so distorted that it deforms the outside seal, and the threaded hole is still partly within the nose-cup, the leak test will be valid.

Figure 5: Properly mounted PC4 gas mask

5. Install a NATO thread canister mount plug onto the mask if appropriate (the plug is stored screwed in on surface of leak tester as shown in Figure 1). A light hand-tight torque is sufficient.

6. Close the pressure bleed valve on the side that is being tested (P1 or P2) and pump the bulb to inflate the face-form bladder and create a seal between the bladder and the mask. The amount of pumping required will vary depending on size and type of respirator. Four pumps are normally sufficient for most masks. Fewer pumps may be required for smaller masks, or more for larger masks (up to 10 pumps are acceptable – manual recommends 8-10 pumps for a large respirator but this is usually not necessary).

Caution: DO NOT OVER-INFLATE THE BLADDER. This can damage its integrity.

7. Wind the timer clockwise to the stop, or use a stop watch for a 45 second count down.

8. Close the bleed valve on the appropriate vacuum squeeze bulb (V1 or V2). Pump the bulb to draw a vacuum into the mask until the gauge reaches or exceeds the green section of the dial (Figure 6). Generally 2 pumps will be sufficient. If the vacuum will not reach the green area, re-don the respirator on the face-form and try again using 4 pumps for the face-seal. If the vacuum still does not reach the green area, deflate the face-form, check the donning of the respirator and re-inflate

using 5 pumps for a larger mask or 3 pumps for a smaller mask. Continue adjusting number of pumps until vacuum can be drawn.

a. In general, for any type of mask, an extra-small or small mask can be tested with 2 to 5 pumps, a medium with 3 to 6 pumps and a large or extra-large with 4 to 7 pumps.

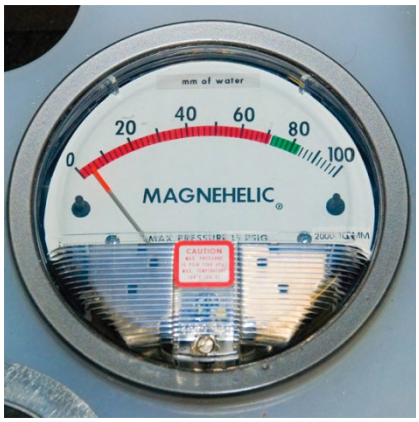

Figure 6: Pressure indicator gauge – 0 is no vacuum, 100 is maximum vacuum

9. Slightly open the vacuum bleed valve until the vacuum gauge indicator is exactly at the top of the green sector. Start the timer by hitting the small button on the timer dial.

10. At the sound of the timer bell (denoting 45 seconds has passed), note the reading on the gauge indicator. If the indicator is still in the green section, then the mask has passed the leak test. If the indicator is in the red section (or in between), then the mask has failed.

11. Record date of test, mask ID and pass or fail information.

12. If a mask fails, then:

    a. check to verify that the canister mount plug is installed and tightened,

    b. check that the mask is seated properly on the bladder, including under the chin (it may be necessary to tighten the respirator straps and/or readjust the bladder pressure), and

    a. check that the harness is fully extended without any folds or buckling.

13. The face-form may also be too dry for an effective seal. If this could be the case, perform the following;

    a. loosen and remove the mask,

    b. re-wet the face-form with water using the spray bottle,

    c. remount and tighten the respirator,

    d. wet any valves that may be leaking, and

    e. then re-test.

14. If after additional adjustments the mask continues to fail the leak test, it can be concluded that the mask has failed.

15. At the end of the test, partially open both bleed valves, remove the canister mount plug, loosen mask straps, and remove the mask.

16. Blot dry any excess moisture from the mask (e.g. with clean paper towel).

17. If the mask passed the leak test, then return to service (or reattach the canister to the mask and return to the user). If the mask failed the leak test, then tag it and remove it from service.

4.6 Leak testing using the Mask Integrity Test Accessory

The Mask Integrity Test Accessory (MITA)[6] quantitatively measures mask leakage using particle counting (using a PortaCount®), and also has a probe accessory that permits detection of the general area of the leak. This unit has the ability to run separate tests to check specific areas of the mask, including the outlet valve and the drinking tube. The MITA is capable of working with most facepieces, although accessories may not be available for a given mask which may have an impact on the capability to perform a complete diagnostic check (check with the supplier of the mask or the MITA).

The MITA can also be used to test pressure changes only, and pass/fail levels can be set by the operator.

The procedures for leak testing using the MITA are as follows.

1. Refer to Mask Integrity Test Accessory (MITA) Model 8120 operator's manual for detailed instructions.

2. Set up leak tester on a level surface at a height comfortable to the user with the larger part of the case (the lid) on top.

3. Perform a "Self Check" of the MITA every 24 hours.

4. If applicable (for masks where there is no MITA mask adapter kit available), after a successful "Self Check" define the testing parameters and procedures by going into the "Settings Menu" and selecting on the "Define Mask Protocol" button. Enter the default password "PROTO" (if not already changed) and disable the "Drink Tube (DT) Test" and the "Exhalation Valve (EV) Leak Test", and SAVE.

5. Return to main menu and enter the "Test Masks" screen.

6. Ensure PortaCount® is connected and turned on. Connect sample tube to headform base.

7. Install filter plug onto mask and don onto headform.

8. Cover mask with hood that provides the particulate enclosure and press enter to start the test.

9. If the mask passed the leak test, reattach the canister then return the mask to the user. If the mask failed the leak test, examine and re-test. If the mask consistently fails then tag it and remove from service (and return the canister to the user).

[6] Manufactured by TSI (www.tsi.com)

4.7 Donning the mask

4.7.1 Donning procedure: Airboss PC4 respirator

Once a mask has passed the leak test, it is ready to be fit-tested on the individual to whom it is issued. The examples following describe detailed donning and fit-testing procedures for the PC4.

1. Check that the filter has been correctly attached. The filter should be hand-tight (it should not spin) and should be the correct filter choice for the environment; a fit-testing canister may be used if the donning is part of a fit-test activity.
2. Check that the mask is free of cuts or tears in the rubber components. There should be no chips or cracks in the plastic components and the eye lenses should be optically clear.
3. Check that the lower two bottom straps are fully slackened prior to donning.
4. Doff any interfering equipment e.g. headgear and glasses. Corrective eyewear, if necessary for the user, should be installed in the mask.
5. Support the mask by holding the front of the mask below the eye lenses.
6. Place thumbs over bottom straps as illustrated in Figure 7.

Figure 7: Mask with harness pulled over

7. Insert chin into the mask's chin-cup first.
8. Pull mask over the face as shown in Figure 8 while holding any hair back that might lodge in the seal.

Figure 8: Chin inserted into mask and hair pulled back from sides and forehead

9. Grasp the head harness tab, and pull it up and over the back of the head as shown in Figure 9.

Figure 9: Donning head harness

10. Pull the cheek straps gently at the same time so that they are tight but comfortable. Ensure that the straps lie flat against the head but do not touch the ears as shown in Figure 10.

Figure 10: Tightening the cheek straps

11. Once the mask has been donned, cover the canister inlet with the palm of the hand and breathe in to perform a negative pressure seal check according to Figure 11.

12. Hold breath for 5 to 10 seconds.

13. The mask should collapse against the face and remain collapsed while breath is held.

14. The collapsed mask confirms mask is leak-tight. If it does not, check for leaks and attempt to collapse the mask again.

Figure 11: Negative pressure check

15. If donned correctly, PC4 mask will look as shown in Figure 12.

Figure 12: Left to right – front view, rear view, and side view of a properly donned PC4 mask

NOTE: Although, the above procedure for donning the PC-4 respirator supersedes the manufacturer's recommendations, this methodology prevents both the degradation of the rubber seal and the breakage of clips caused by the repeated donning and removal of the mask.

4.7.2 Visual inspection of donned PC4 respirator

1. Ask the user to sit or stand (without talking if immediately prior to QNFT) for 5 minutes. Points to inspect and address if needed include:

    a. hairline should lie outside the mask sealing surface (which may be a few cm away from the outside edge of the mask),

b. eyes should be in top 3rd of eye piece (or as specified by supplier),

c. corrective eyewear should be properly aligned,

d. nose-cup should not be overly deformed, maintaining a gentle seal,

e. no hair shall be under the seal (bangs, sideburns or long hair can become trapped in seal and create a leak),

f. wearer shall be clean shaven (see reference [3] Annex M for acceptable configurations),

g. ensure that the head harness is pulled down towards the nape of the neck and is not wrinkled,

h. check for under- or over-tightening,

i. ensure canister is screwed in properly (not cross threaded or loose),

j. lower hair buns below head harness level as the harness may be pulling the bun to the head instead of the mask to the face, which can present itself as a leaking mask, and

k. perform negative pressure test to confirm a seal can be achieved.

2. Also, re-confirm comfort for the wearer and if necessary, allow the wearer to re-adjust the respirator on their face. If sufficient comfort is not achieved, consider re-sizing the facepiece, or changing nose-cup size if applicable.

4.8 Fundamental fit test

Fundamental fit testing by performing a quantitative fit test (QNFT) achieves accurate sizing of a respirator for an individual FR and should occur every two years or yearly when possible. This QNFT test is performed without the wearing of DPE or other personal equipment and an example activity routine to be performed is given in Table 1.

Before the fundamental fit test, the user should be clean shaven (to ensure a tight fit around the face), and refrain from smoking for at least 30 minutes (spurious particulates can skew PF values). As described in the previous section (section 4.2), the size of RPD chosen should be based on manufacturer's instructions and/or use of a sizing tool. After donning by the wearer, the RPD should be inspected to make sure it has been properly donned, followed by a 5 minute wait with no talking. The 5 minute wait is used to ensure that particles are cleared from mask, the mask seal has warmed to the face for more accurate fit test results, and the mask size chosen is comfortable to wear.

Table 1: CSA-Z1610-11 quantitative fit test activity routine

Activity	Duration (min.)
Breathe normally	1
Bend over repeatedly once every two seconds	1
Vigorously shake head twice, then breathe normally[1]	1

[1]Test data recorded while the head is being shaken shall not be used for determining test result

The fundamental fit routine (Table 1) is composed of three activities; the first allows the respirator to be tested for leakage without movement (i.e. breathe normally), the second activity tests the likelihood of leakage by dislodging during movement (i.e. bend over repeatedly once every two seconds), and the third activity tests the ability of the respirator to reseat after it has dislodged (i.e. vigorously shake head twice, then breathe normally). As described in Part A [1], other activity routines may also be used.

While different equipment and methods are available, the QNFT developed and validated for this document is performed with a TSI PortaCount® Model 8020 (older model) or 8030/38 (newer model) and salt particle generators (TSI particle generators Model 8026), in a tent or similar enclosure. The use of salt is recommended for the QNFT described in the standard operating procedure (SOPs) described herein, and is the only procedure explained. For any other types of challenge material refer to CAN/CGSB/CSA-Z1610-11 [2].

The pass/fail criteria must be established in advance of the QNFT (see Record-keeping). For CBRN APRs and PAPRs, this is usually based on an overall (average) fit factor[7] of 10,000 but may be as high as 20,000 (e.g. for the user of a CBRN APR or PAPR who may enter the hot zone of powder event, as defined in the standard CAN/CGSB/CSA Z1610-11 [2]).

Failure to pass the QNFT may mean the mask is the wrong size, it was donned incorrectly, or it is defective or assembled incorrectly; hence following procedures described above reduce the likelihood of a failing QNFT. Detailed troubleshooting is given in section 4.9.

In the absence of such effects, a passing fundamental fit result means that the correct size of respirator has been chosen in order to assure fit of the respirator according to the requirements outlined in the standard CAN/CGSB/CSA-Z1610-11 [2]. Subsequent to a successful QNFT, each individual shall perform a qualitative integration test while wearing their full PPE to assure that no integration issues are preventing proper respirator fit. This may be followed by a quantitative integration fit test to measure RPD protection performance for the individual. For a given individual, it may be ultimately necessary to select different sized equipment if interferences exist amongst items.

4.8.1 Equipment set-up

1. Construct a suitable enclosure such as a tent (Figure 13, and see Annex B) within the test facility, erected in a manner that minimizes airflow in and out (e.g. tape leaky closures and ensure the door flap is closed). Depending on the size of the tent, multiple individuals can be tested at the

[77] The fit factor describes the factor by which protection is increased by wearing a chosen respirator while performing a fit test routine. Depending on the details of the test and the respirator, it may or may not relate well to performance in use.

same time; each individual should have adequate space to perform the activities and be free of trip hazards.

Figure 13: Fully assembled fit testing enclosure

2. If needed to maintain room temperature and relative humidity below 60%, connect an air conditioner/dehumidifier/heater so that it can provide climate control to the tent, and connect it to an adequate power source.

3. Load the reservoir of each particle generator with a solution of one crushed salt tablet dissolved in water to the fill line. See Annex A for detailed instructions on the use of particle generators. Approximately 2 generators per 2 person-sized tent may be necessary to achieve a target airborne concentration of 40,000 to 60,000 particles/cm^3.

4. Place the particle generators inside the tent (along the perimeter in a manner that minimizes the risk of tripping); connect them to a power source, and turn them on (at least 10 minutes prior to starting a fit test).

5. Set-up the test station (table and chair) outside the tent, adjacent to its sampling port (hole).

6. Set-up the PortaCount® and computer on the table outside the tent. This will involve powering up, installing the alcohol soaked wick, connecting the twin cable and extending into the tent through the sampling port, connecting the HEPA filter to the end of the clear sample tube (in the tent), running the daily checks, and starting up the fit test program, with the desired protocol and test candidate database (as required). For additional detailed information on operation of the PortaCount® for various applications, see Annex C (for model 8020), Annex D (FitPlus 3™ software), Annex E (for models 8030 and 8038), and Annex F (FitPro™ software).

7. When the daily checks are complete, remove the HEPA filter from the end of the sample tube and attach a drinking tube adapter in its place.

8. Ensure that the salt aerosol concentration is in the 40,000 to 60,000 particles/cm^3 range by monitoring with the PortaCount® (and/or observing it earlier during the daily checks). Adjust the

conditions by manipulating the output adjustment screw located on the top of the particle generators, altering the number of functioning particle generators, and/or by changing the air-tightness of the tent. (Note also that particle generators can become clogged or become disconnected from the power source.)

4.8.2 Test procedure

1. Before starting the test on a given individual and before they have donned the respirator:

   a. ensure that the candidate is clean-shaven,

   b. if the candidate is a smoker, then ensure that they have not smoked for a minimum of 30 minutes prior to the QNFT, and

   c. ensure that the candidate has been trained in the proper donning and doffing of their respirator (section 4.5), consistent with the respirator manufacturer's recommended procedures (provide instruction if necessary, and/or show them a video demonstration if available).

2. Prepare to connect the PortaCount to the respirator by one of the following means.

   a. If utilizing a TSI drinking tube adapter for use with a PortaCount®, then ensure drinking device of the candidate's respirator is clear of moisture. To clear the tube, perform the following;

      i. attach a drinking tube adapter,

      ii. ensure that the 1-way valve inside the drinking tube is open, and

      iii. blow out the moisture with a can of compressed air [directed away from eyes], or, alternatively, use a modified syringe to suck out the water, adapted for this purpose with a PortaCount® adapter.

   b. When possible, remove the straw of the drinking device [the portion inside the mask that allows the individual to drink – it may otherwise come in contact with candidate's face and interfere with the fit test], and ask the candidate to keep it in their pocket for safe keeping until after the ISQ testing. Show them how it can easily be reattached and remind them at the end of the ISQ testing to reinstall it before leaving with their respirator.

   c. If a PortaCount® drinking tube adapter is not available, a special NATO thread adapter can be used as a sampling location. The NATO thread adapter is essentially a spacer between the mask and canister with a port that allows for the PortaCount® to be connected. A tube is attached on the inside of the adapter that travels through the inhalation valve and into the nose-cup of the respirator.

   d. SCBA systems can be fit tested by using a special fit testing mask or canister adapter kit. The fit testing mask must be of the same facial dimensions and provide the same type of seal around the user's face. If provided, the canister adapter kit works in the same way as the NATO thread adapter with a tube that is placed through the inhalation valve and into the mask.

3. Describe (and demonstrate) the test protocol to the candidate and what will be asked of them.

    a. They will be asked to don the respirator and sit/stand outside the tent for 5 minutes, while ambient particles clear out of the mask.

    b. They will be asked not to talk during this time and until the end of the test (to avoid generating particles inside the mask). All communication should be by hand signals, such as thumbs up.

    c. At the end of the 5 minute wait, they will be asked whether they are suffering from any acute discomfort.

    d. If the answer is yes, an alternative size mask will be chosen; if the answer is no, then the candidate will proceed to the next step.

    e. They will enter the tent containing a safe atmosphere of salt (sodium chloride). Note that the airborne concentration will be less than would be experienced beside the ocean on a windy day.

    f. The time spent inside the tent will last approximately 3 minutes during which they will be asked to perform the following 3 activities:

        i. stand still for 1 minute while breathing normally,

        ii. bend over once every two seconds for 1 minute [demonstrate], and

        iii. shake head vigorously from side-to-side twice [demonstrate] and then stand still again for the remainder of the final minute [testing to see if a somewhat dislodged mask will effectively reseal itself to the face].

4. Ensure that the candidate's respirator is equipped with particulate filtering canister(s), known to be low dust generating and capable of a filtration efficiency of 99.997%. [Their own training canister may be suitable, but the ISQ Assessment Personnel should also have a supply of pre-tested canisters that meet these criteria, and which are carefully handled in such a manner that will minimize dust generation from filter damage, or contamination through unsealed openings during storage.]

    a. For a PAPR, the blower hose may be disconnected at the mask and a particulate cartridge installed in its place. Alternately the blower is simply left turned off. [This is necessary because the respirators are tested in negative pressure mode; in positive pressure mode, blowers may generate extraneous particles].

5. Ask the candidate to don their respirator (without DPE or other equipment), tighten the straps, and check the seal by performing positive and negative pressure leak tests [i.e. by closing off the exhalation valve with their hand and exhaling, followed by closing off the inhalation valve with their hand and inhaling]

6. Inspect for a properly donned respirator and ask the user to sit or stand without talking for 5 minutes.

7. At the end of the 5 minutes lead the candidate into the tent and connect their drinking tube to the drinking tube adapter on the end of the clear sampling tube.

8. Return to the PortaCount® outside the tent and begin the QNFT.

9. Either prepare to log the test data in the PortaCount® and/or associated computer (which also requires entering information about each test candidate and respirator, in advance or at the start of each test) or be prepared to record this information in a separate paper log.

10. Follow the PortaCount® instructions for the fundamental fit routine, while directing the candidate through the individual activities.

11. If wearing an APR or PAPR, each individual needs to achieve a PF of >10,000 if respirator is to be worn in the support or protective action zone, and a protection factor of >20,000 if respirator is to be worn in the hot zone during a CBRN event, where the respirator is tested in negative pressure mode. If wearing an SCBA, each individual needs to achieve a PF of 500[8] using a fit-testing facepiece of equivalent size, or the given facepiece if it is capable of direct attachment to the PortaCount®.

12. If the candidate passes the QNFT (i.e. overall PF ≥ 10,000[9] or other specified value), then:

    a. disconnect their drinking tube from the test apparatus and invite them to exit the tent and remove their respirator,

    b. inform them that the desired respirator fit was achieved, and

    c. direct them to the next test station (for the Qualitative Integration Assessment). They will need to take their full respirator, DPE and other relevant personal protective equipment such as a helmet.

13. If the candidate fails the QNFT, then:

    a. refer to next section (section 4.9) for troubleshooting,

    b. if problems with the test equipment are suspected, then review the troubleshooting information in Annex G and

    c. if an effective fit cannot be achieved, then select a new size and/or model of respirator and repeat the previous respirator portions of the ISQ test methods, including the QNFT (with another 5 minute wait, etc.).

14. Before continuing to the next test candidate, ensure that the PortaCount® sampling tube has not accumulated excessive moisture, as may occur during multiple fit tests. Excess moisture can be blown out with compressed air, or the twin tubing can be replaced if an extra set is available.

4.9 Failed mask (PC4) troubleshooting check list for QNFT

- ❑ Leak test and visual inspection

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[8] 1,000 under Z94.4-11.

[9] A very high PF (e.g. 999,000) may indicate a problem with the drinking tube PortaCount® adaptor not opening. Refer to Annex G for troubleshooting.

- ❑ Check valves for dirt/debris (clean when required)
- ❑ Replace valves if old/dirty valves are present
- ❑ Check canister mount rotation
    - ❑ If canister mount rotates then the mask is Beyond Economical Repair (BER)
- ❑ Check torque of both speech transmission devices
- ❑ Check lugs for tearing
    - ❑ If it is torn then the mask is Beyond Economical Repair
- ❑ Check for improperly inserted eye pieces
    - ❑ Can be a source of a leak
- ❑ Check for holes around the base of the canister mounts
    - ❑ If there are holes then the mask is Beyond Economical Repair

- ❑ Is the person a smoker?
    - ❑ If they are a smoker then ask when they had their last cigarette. They may be required to sit aside for 30 minutes to clear lungs of smoke generated particles
- ❑ Hair in seal
    - ❑ Remove hair and re-don respirator
- ❑ Mask seal over hairline
    - ❑ Needs smaller size mask
- ❑ Head harness pulled down and back by tag
    - ❑ Redo QNFT
- ❑ Straps tightened appropriately
    - ❑ If loose, tighten and redo QNFT
    - ❑ If over tightened, loosen and redo QNFT
- ❑ Hair-bun too high
    - ❑ Lower bun below head harness level at back of head and redo QNFT
- ❑ Check canister
    - ❑ Is canister cross threaded
    - ❑ Is canister tightened appropriately
    - ❑ Ensure canister washer is in place
    - ❑ Check reliability of canister by testing with new canister
- ❑ If the mask appears to be the appropriate size but it is soft with little rigidity, then exchange for a new mask of the same size

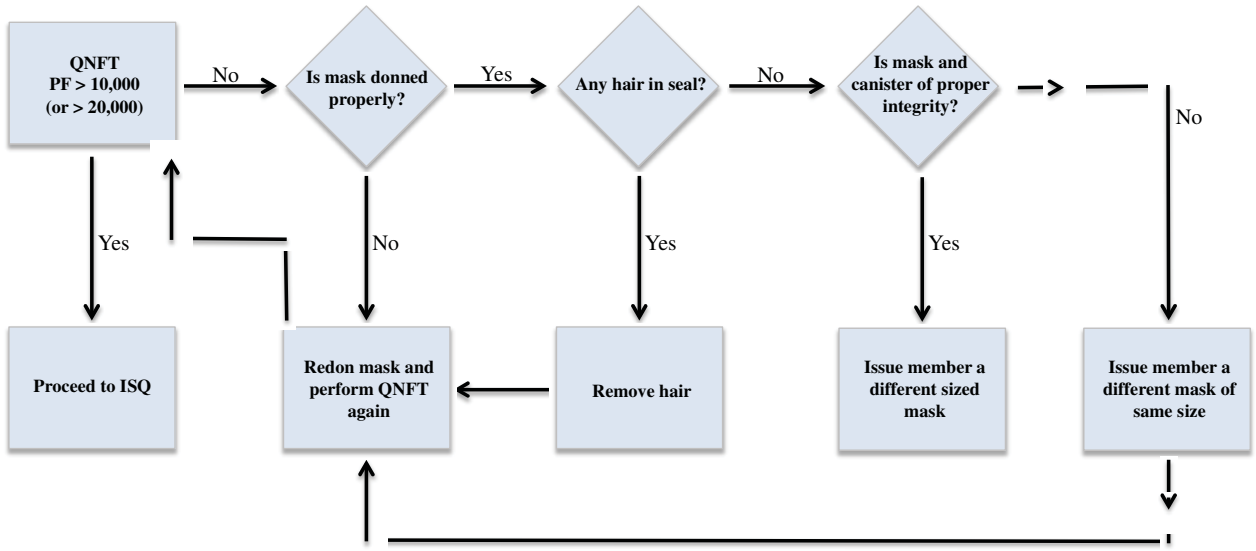

Figure 14: Troubleshooting for failed QNFT

4.10 Qualitative integration assessment

General PPE integration issues will have been resolved previously by a separate test team for a prequalified PPE system that is being used in a specified manner, although specific individuals may still present with problems. A visual check of the system integration by a person knowledgeable about possible integration issues is the next step in ISQ (qualitative integration assessment or QLIFT). If applicable based on existing policies, it is acceptable to bypass QLIFT and proceed directly to the Quantitative Integration Fit Test (QNIFT), although conducting the qualitative procedure may circumvent and solve problems so that QNIFT is more likely to be successful.

1. Instruct test candidate to don the respirator if not already wearing.
2. Instruct test candidate to don the remaining personal protective equipment (PPE) as worn in the field. An example of a donning procedure for incorporating PPE is described below.
    a. Start with donning of 1 or 2 piece suit by starting with the trouser portion.
    b. Don duty footwear and CBRN overboots.
    c. Pull each pant leg of the suit over the associated boot and secure any straps, suspenders or zippers that should be done up prior to donning the jacket/hood portion.
    d. Pull up the torso part of the suit or put on the jacket in case of a 2 piece suit.
    e. Place hood over the head of individual and ensure that rubber/fabric of hood runs along the edge of the respirator (Figure 15).

Figure 15: Rubber seal of hood runs along the edge of respirator

f. Check if exterior part of drinking tube is outside the hood (if tube is inside, take it to the outside).

g. Don gloves.

h. Fasten crotch straps or any other straps if applicable.

i. Put on body armour if applicable.

j. Attach RPD canister, blowers, hoses, etc. if applicable.

k. If applicable, place helmet on the individual's head, attach and tighten the chinstrap. Helmet should not rest on brow of mask visor or eyepieces; ensure at least one finger's width separation to the helmet (Figure 16). It may be necessary to fit the helmet with padding or an available strapping system to ensure a proper distance.

3. Check with individual for the comfort of suit/respirator.

Figure 16: Fitting of helmet A) from front B) ensuring minimum of one finger width between top of mask and helmet C) from side D) from below

4. Inspect the PPE integration of the test candidate visually for remaining issues that might cause mask dislodging.

5. Ask the candidate to cover the canister intake with the palm of hand and breathe in to perform a negative pressure seal check as executed in the donning procedure.

6. Follow the qualitative integration fit testing procedure flow chart in Figure 17. A “pass” is required for each step.

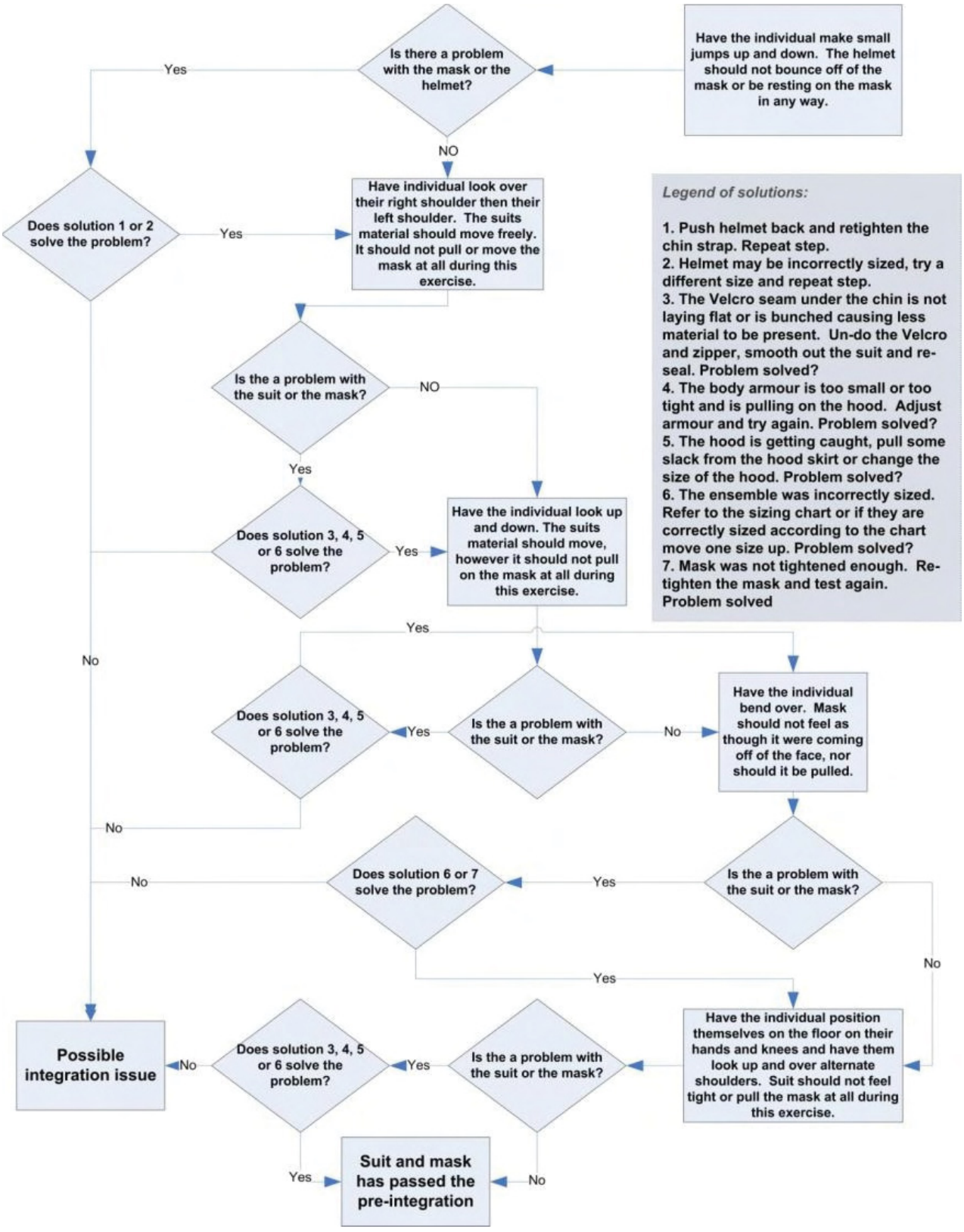

Figure 17: Qualitative integration assessment flow chart

4.11 Quantitative integration assessment

The optional quantitative integration fit test (QNIFT) is conducted with the individual wearing the full CBRN personal protective system and performing an activity routine that is designed to place stress on the respirator. Stress can be caused by other system components and as such, it is essential to determine the cause in order to properly protect the first responder during a CBRN event. The test is otherwise identical to the QNFT, performed in a tent with salt aerosol and monitored with a PortaCount®.

The pass/fail criteria must be established in advance of the QNIFT (see Record-keeping section 4.12). For CBRN-APR and PAPR, this is usually based on an overall (average) fit factor of 10,000 but may be as high as 20,000. Integration problems that are identified as a result of any individual test must also be resolved before the individual is qualified to use the CBRN-protective system.

4.11.1 Test procedure

1. Set up the tent, particle generators and PortaCount® in the same manner as described under Fundamental Fit/QNFT (above). [Positioning of the PortaCount®/sampling port (hole) in the tent must also be sufficient to allow for small jumps and on-hands-and knees activities. If necessary, the PortaCount® must be moved inside the tent, closer to the test candidate (e.g. on a small stand). The sampling tube must not be extended more than the few inches needed to add a drinking tube adapter. Longer tubes prevent proper purging of particles between the sampling of the outside (ambient) and mask values.]
2. Ensure that the RPD is fitted with a low dust, high particulate filtration efficiency canister (>99.997%) and that the straw of the drinking device has been removed if it is likely to interfere.
3. PAPRs are to be tested in negative pressure mode (and isolated from the blower and hose to avoid interference from blower generated or other extraneous particulate). Usually, the blower hose is disconnected from the mask and a particulate cartridge is installed in its place. The hose must be secured (such as with tape or tie wraps) in a similar orientation to its normal positioning. Alternately, the blower is left connected but turned off, provided the system is known to be clean of extraneous particulate.
4. Ask the candidate to don the complete CBRN-protective system and inspect.
5. Describe and demonstrate the test protocol below to the candidate, and what will be asked of them (or show them a prepared video).
6. They will again be asked to sit/stand outside the tent with donned respirator for 5 minutes, and without talking, while particles are cleared out of the mask. [The time may already be elapsing if they do not talk during this orientation]
7. They will then enter the tent using the same salt aerosol concentration as in the QNFT.
8. The test inside the tent will last approximately 5 minutes during which time they will be asked to perform the following 5 activities (Table 2):
    a. standing still for 1 minute,
    b. rapid bending over for 1 minute with a rest every 15 seconds [demonstrate],
    c. look over left shoulder 5 times, right shoulder 5 times, look at ceiling and then floor 5 times, for a total of 1 minute [demonstrate],

d. small jumps in place for 1 minute [demonstrate], and

e. on hands and knees, chest low to the ground, repeatedly look back over alternate shoulders (as far as possible) for 1 minute [demonstrate].

9. Lead the candidate into the tent and connect their drinking tube to the drinking tube adapter at the end of the clear sample tube.

10. Return to the PortaCount® and begin the QNIFT. Follow the PortaCount® instructions for the QNIFT routine, while directing the candidate through the activities of Table 2:

Table 2: QNIFT Activity Routine

Activity number	Activity	Duration (minutes)
1	Stand still, normal breathing	1
2	Bend over repeatedly and rest in 15 second intervals. The speed of the bend should be very fast (i.e. once every second) or at a speed deemed safe with the equipment worn.	1
3	Stand and look over left shoulder 5 times (15 seconds), look over right shoulder 5 times (15 seconds), look at ceiling overhead and floor by feet 5 times (30 sec).	1
4	Small jumps in place repeatedly 30 times (once every two seconds)	1
5	On hands and knees, chest low to the ground, look up as high as possible, and look back over alternate shoulders as far as possible (once every 2 seconds)	1

11. If the test candidate fails, go back to the qualitative integration assessment to investigate the integration issue.

12. Before continuing to the next test candidate, ensure that the PortaCount® sampling tube has not accumulated excessive moisture, as may occur during multiple fit tests. Excess moisture can be blown out with compressed air, or the twin tubing can be replaced if an extra set is available.

4.12 Record-keeping

A system of record-keeping must be developed and maintained for the ISQ program. The minimum information to be documented includes the following:

- name of the person tested,
- body weight and sizing dimensions, as applicable for the personal protective equipment components considered within the program (e.g. height, chest, shoulder width, waist, leg inseam, head circumference, and facial size based on sizing tool and/or facial dimensions such as facial length (menton-Sellion, distance from bottom of chin to nose indent between eyes) and width across check bones (bizygomatic breadth),
- date of each test,
- specific make, model, serial number (if applicable) and size of all system components,
- type of ISQ (qualitative or quantitative) with details of the methods,

- make, model and serial number of test equipment,
- pass/fail criteria and results of the individual tests,
- comments on integration issues and methods used to resolve them,
- date of next required ISQ, and
- name of the person conducting each test.

4.13 Maintenance of APR

Periodic Cleaning and Sanitizing:

- ❑ Remove the mask from the carry bag
- ❑ Remove canister and Voice Amplifier if present
- ❑ Open the outlet valve cover, let it hang
- ❑ Using a product that will both clean and sanitize at the same time:
  - o e.g. use solution of e.g. 90 mL of Confidence Plus[10] to 10 litres of water at a temperature of 20 to 40 °C
  - o Agitate the mask for thirty seconds by hand
- ❑ Remove the mask from the solution and drain the inside and outside of the mask

Cleaning Drinking Device:

- ❑ Fill clean canteen (that matches drinking connector) with Confidence Plus water mixture cleaning solution and cap the canteen
- ❑ Insert drinking device into cap
- ❑ Flush the cleaning solution through the drinking tube
- ❑ Remove drinking device
- ❑ Fill canteen with clean water and re-cap
- ❑ Insert the drinking device in cap
- ❑ Flush the water through the drinking tube with the inside of the mask facing downward
- ❑ Rinse the mask thoroughly in clean water
- ❑ Remove the mask from the rinse solution and drain the water from the inside and outside of the mask
  - o To drain liquids from the inside of the mask, tilt the inside of the mask downward and at the same time pull the face seal away from the inside of the mask, allowing the trapped liquid to escape

[10] MSA Inc., http://www.msanet.com/emessage/pdf%20files/1001-13-ConfidPlus.pdf

To dry the mask – wipe the inside of the mask using a clean cloth or paper towel

- Ensure re-entry seal of free of any excess moisture
- Wipe eyepieces
- **NOTE:** Great care should be taken to prevent scratching of the eyepieces.

DO NOT HANG THE MASK BY THE HARNESS OR STRAPS, APPLY HEAT, OR TURN THE FACEPIECE INSIDE OUT TO HASTEN DRYING.

- Allow the mask to air dry
- All valves must be correctly seated
- Install the canister and store in carrier

4.14 Alternative qualified system

The employer is responsible for providing an option of an alternative qualified system approved by CSA Z1610-11 [2] upon a non-satisfactory ISQ validation. The alternative qualified system is expected to meet the performance requirements specified in the CSA Z1610-11 standard [2]. The employer will ensure that the responder cannot be assigned duties leading to excessive exposures, if a satisfactory ISQ cannot be achieved with a qualified system.

5. Conclusion

This operating procedure provides detailed guidance and examples for Individual System Qualification validation and implementation as per the standard CAN/CGSB/CSA-Z1610-11 [2] to protect first responders during CBRN events. Z1610-11 effectively organizes the diverse information present in all jurisdictions and aids in a providing guidance for implementation of the ISQ procedures. Based on the information in the documents produced under this project, first responders in Canada will now have well-elucidated procedures and protocols for implementing ISQ programs to assure adequate respiratory protection for CBRN first responders.

6. References

[1] Farrar G.J., Gill M., Bodurtha P., Gudgin Dickson E.F. (2014). Implementation of Individual System Qualification (ISQ) in a CBRN Respiratory Protection Program, Part A: Guidance. Royal Military College of Canada Report CPT-1302. May 2014.

[2] Canadian Standards Association (2011). Standard on Protection of First Responders from CBRN Events. CAN/CGSB/CSA-Z1610-11.

[3] Canadian Standards Association (2011). Selection, use, and care of respirators. CAN/CSA-Z94.4-11.

[4] Gudgin Dickson, E.F., Bodurtha, P., Beardall, T., Harrison, B., Daynard, D. (2011). Respiratory Protection Program for CBRN protection: Summary report. Royal Military College of Canada Report CPT-1101. Unclassified unlimited distribution.

[5] Liang, S.H., Harrison, B.H. (2005). Quantitative fit testing of military gas masks with the TSI Portacount: Part I - Identifying the limitations. J. Intl. Soc. Resp. Protection 22:47-54.

[6] Harrison, B.H., Liang, S.H. (2005). Quantitative fit testing of military gas masks with the TSI Portacount: Part II - Quantifying the limitations and recommendations for use. J. Intl. Soc. Resp. Protection 22:55-67.

[7] American Society for Testing and Materials (2009). ASTM F1052-09, Standard Test Method for Pressure Testing Vapor Protective Suits.

Annex A TSI particle generator (Model 8026)

A.1 Set-up and operation

1. Fill the reservoir with tap water to the fill line (Figure 18). Warm water works best for dissolving salt.
2. Crush 1 salt tablet with the mortar and pestle and pour the salt into the reservoir.
3. Stir or gently shake the reservoir (with temporary cover in place) to dissolve the salt.
4. Remove the temporary cover and screw the reservoir into the particle generator. The particle generator will run for at least 8 hours on a single filling.

Figure 18: Particle generator and salt solution reservoir

5. Place the particle generator upright on the floor ensuring it is located in such a way that it won't cause a tripping hazard. Do not obstruct the ventilation louvers on the back and bottom of the unit, which could cause overheating. The enclosure may have inlet ports designed to permit the generators to be outside the tent. Connect the power cord into the back of the particle generator, plug it into a wall outlet and turn on the power switch (also at the back of the particle generator).
6. At the end of the day/session, turn off the particle generator and remove the reservoir, then turn the generator back on for 40 seconds (without the reservoir) to purge it of salt solution. After extended use, it may also be useful to run with pure water for 10 minutes.
7. The salt solution should be discarded with fresh solution being made for each day of testing. Do not create an incorrect salt concentration by trying to mix new solution into the old.
8. All parts can be purchased from Levitt Safety Limited[11].

[11] Address: 659 avenue Meloche, Dorval, QC, H9P 2T1 (Tel. 1-866-741-7101).

A.2 Increasing the aerosol output

The particle generator output is factory pre-set for normal use. However, if higher particle counts are needed (and additional particle generators are unavailable), then the output can be increased by turning the output screw, located on the top of the particle generator, clockwise (Figure 19). To restore the factory setting, adjust clockwise to maximum, and then make 3 complete counter-clockwise turns. The screw should turn easily; do not force it.

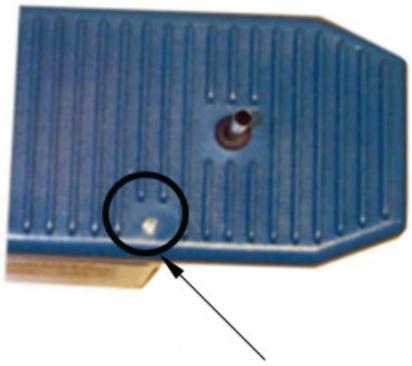

Figure 19: Top view of particle generator showing output adjustment screw

A.3 Cleaning the atomizer nozzle

1. Turn the particle generator off.
2. Remove the salt solution reservoir.
3. Disassemble the atomizer jet assembly in numerical order as indicated in Figure 20, below. The retainer that holds the parts of the jet together can be difficult to remove. If necessary, use pliers to pull down on the tab with a gentle rocking motion. The jet assembly incorporates a small O-ring. Set it in a safe place.

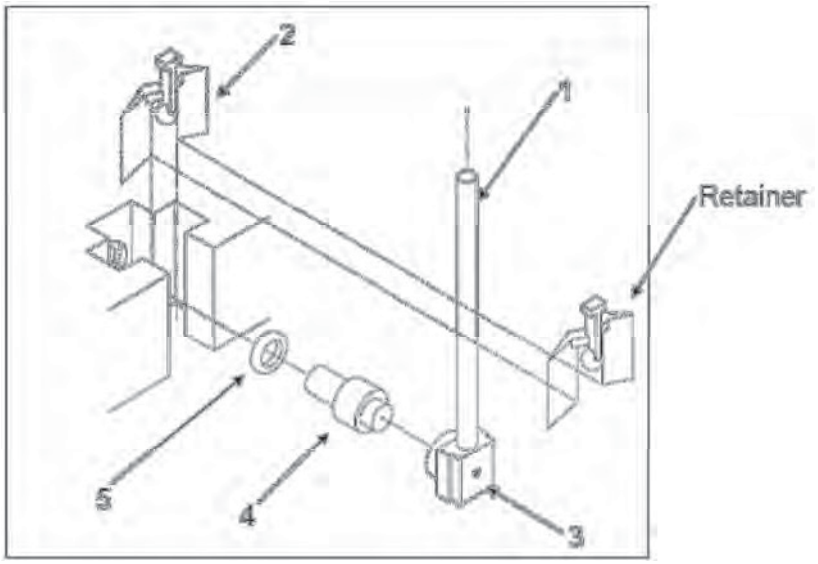

Figure 20: Atomizer jet assembly components

4. Use mild soap and warm water to clean the jet assembly parts. Examine the orifice for plugging. Rinse a second time if necessary. Either use clean compressed air to dry the parts, or air-dry them. Note: The orifice is easily damaged. Do not insert anything in the orifice in an attempt to clean it.

5. Reassemble and install the atomizer jet, making sure that the O-rings are replaced. Make sure that the retainer is pushed in completely.

6. Attach the draw tube.

7. Test the particle generator for proper operation (output) using tap water.

8. For additional maintenance and servicing of generator, contact the supplier.

Annex B Fit test enclosure

An enclosure such as a tent (Figure 13) is required to measure high PFs (>10,000) because the required particle concentration outside the mask is higher than typical ambient concentration in a room; >60,000 particles/cm^3 is required to measure a PF of 20,000. A general layout of a tent suitable for fit-testing two persons simultaneously is shown in Figure 21. It is preferable that the tent enclosure contains windows between the operator and the candidate(s) so that the individual(s) being fit tested can be observed. It is also required that the tent contains one or more holes approximately at table height for PortaCount® tubing to reach inside the tent enclosure to connect to the individual's respirator.

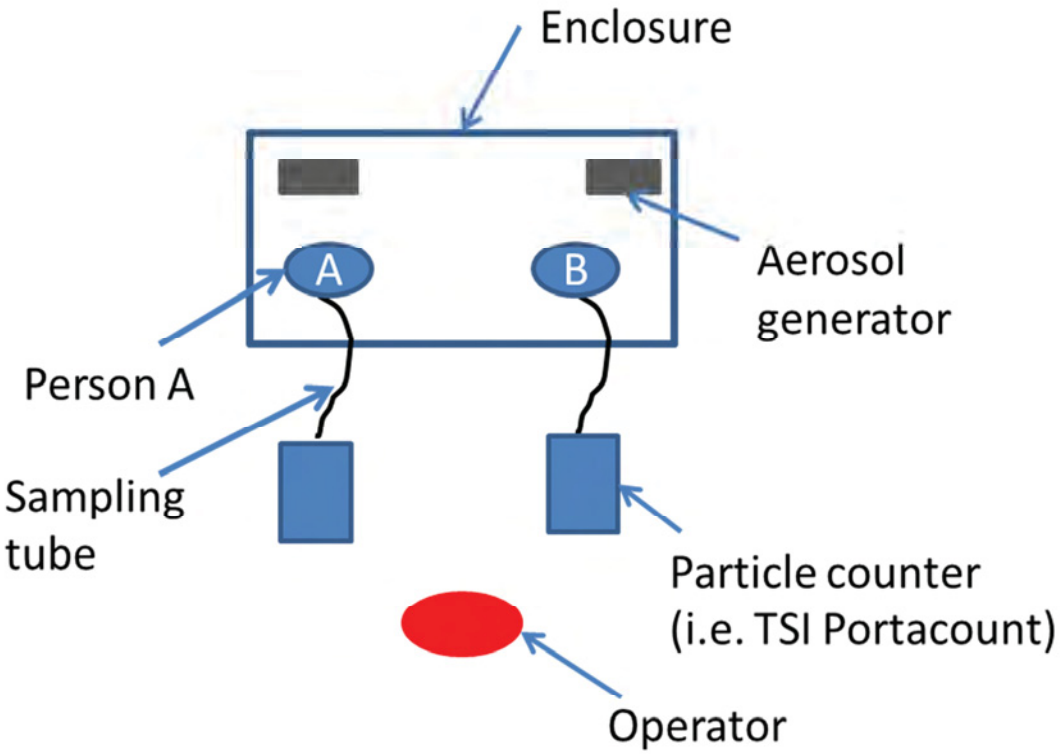

Figure 21: General layout of a tent enclosure used for fit testing of two individuals

Annex C Quantitative fit testing using PortaCount® Plus model 8020 [older model]

C.1 Set-up and operation

1. Remove PortaCount® device, alcohol wick, power cord, twin-tube assembly, and data cable from the carrying case and place on a table set up in front of one of the windows of the fit test enclosure (Figure 22).

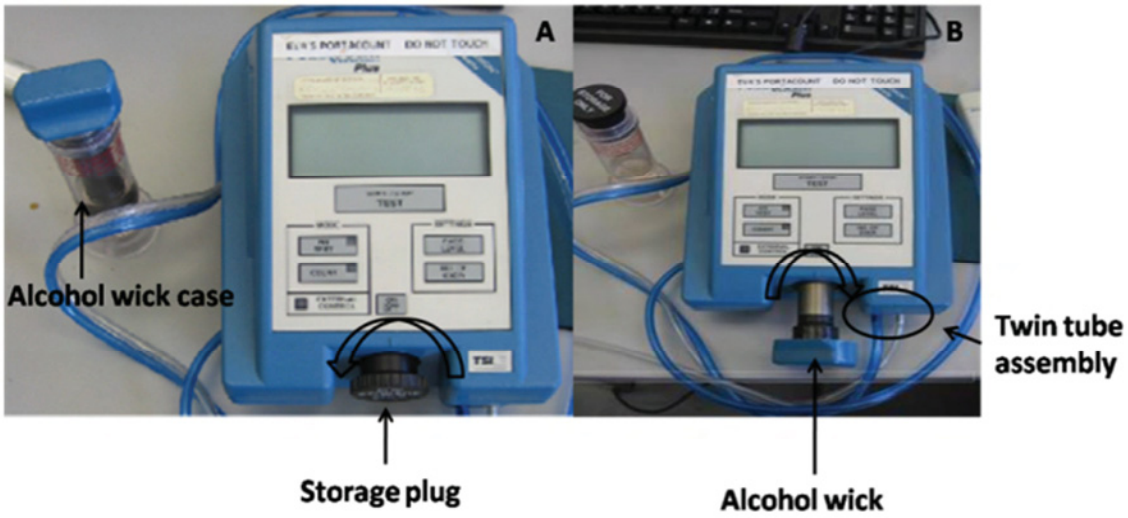

Figure 22: PortaCount® 8020 with storage plug inserted in cavity (picture A) and alcohol wick being inserted in cavity (picture B)

2. Also remove the HEPA filter and a fit test adapter from the case and place in close proximity to the above equipment.
3. Place a laptop/PC together with a power cord in close proximity.
4. Connect power cord into back of PortaCount® and plug into a grounded outlet or power bar.
5. Remove the storage plug from the PortaCount® by twisting the cap counter clockwise, according to Figure 22A.
6. Insert the wick in the cartridge cavity, secure the wick cartridge by gently twisting clockwise to lock cartridge into place, according to Figure 22B.
7. Place the storage cap onto alcohol wick case.
8. Turn on the PortaCount®. The PortaCount® will enter a 1 minute countdown.
9. Connect the blue and clear twin tube assembly (refer to Figure 22B) to the corresponding ports on the front of the PortaCount®. Match the clear sample tube with the silver/white port and the blue ambient tube with the blue ambient port. Extend the other ends of the twin tubing into the enclosure through the sampling port (hole).
10. Attach appropriate drinking device adapter (Figure 23) to the clear (longer) tube.

Figure 23: Drinking device adapter attached to the clear tube of the twin tube assembly

11. To measure the particle concentration in the fit test enclosure, press the "Count" button on the PortaCount® (Figure 24); the indicator light on the COUNT key will turn on.

    a. While in Count Mode the PortaCount® will continuously measure and display particle concentrations in units of particles per cubic centimeter (particles/cm3). The concentration will flash in 1-second intervals (This is called 1-Second Count Mode as the particle concentration displayed is an average over a 1-second period, updated every second).

    b. Pressing the TEST START/STOP key will toggle the PortaCount™ between 1-Second Count Mode and 15-Second Count Mode (Figure 25).

    c. In 15-Second Count Mode the particle concentration displayed will be zero until 15 seconds have elapsed. The PortaCount™ will show 15-second averages, updated every 15 seconds.

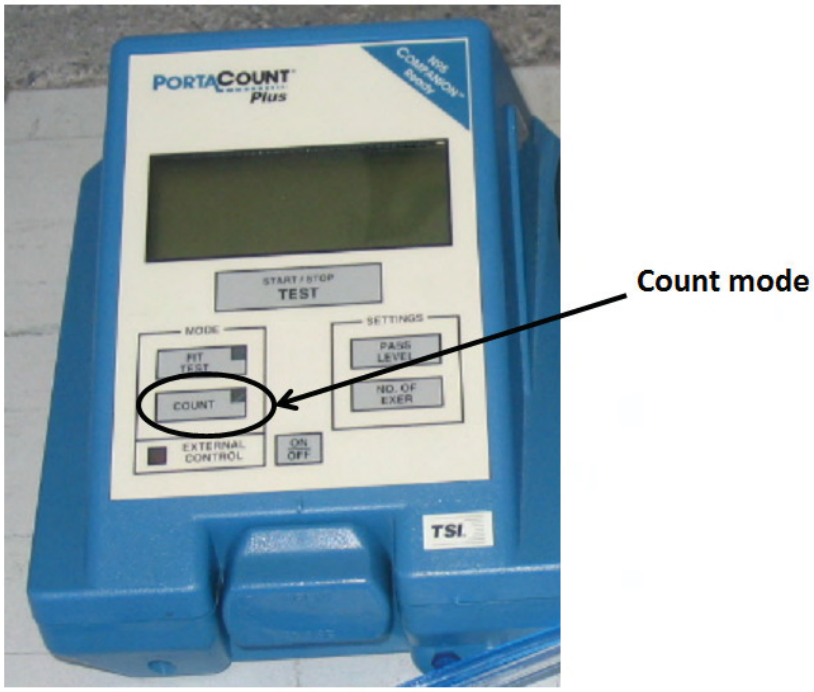

Figure 24: COUNT key on the PortaCount® to press in order to measure particle concentration in real-time.

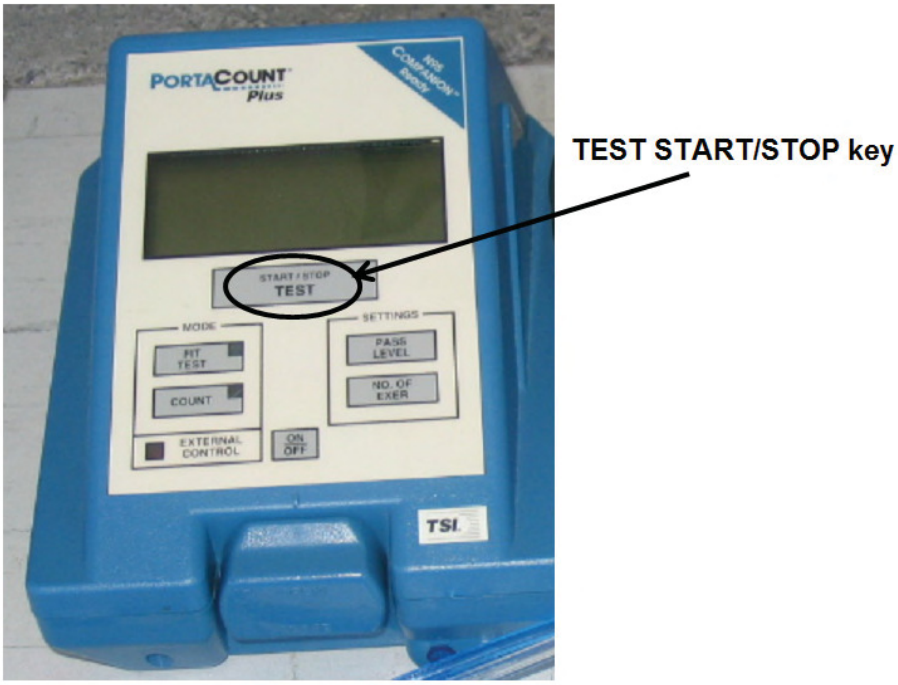

Figure 25: The TEST START/STOP key on the PortaCount™ for toggling between 1-Second Count Mode and 15-Second Count Mode

12. A particle concentration of >40,000 particles/cm^3 (for PF requirement 500 or 10,000) or a particle concentration of >60,000 particles/cm^3 (for PF requirement 20,000) inside the tent enclosure should be established. It is recommended to use a concentration of <100,000 particles/cm^3 to reduce clogging of the instrument when used for an extended period of time. Do not exceed a concentration of 150,000 particles/cm^3.

13. If necessary adjust generator output using the set screw located at the top of the generator according Annex A.

14. After checking the challenge concentration, turn on the computer.

15. Connect PortaCount® to the computer via the data cable (data port in back side of PortaCount® to serial port of laptop). The computer must be loaded with the FitPlus™ software, which is provided in each PortaCount® case. If necessary, visit http://software.tsi.com to download a copy.

C.2 Preparing to fit test using FitPlus™3 software

For reference in this section, for the PortaCount® system, the tube that monitors the outside concentration is called the 'ambient' tube, and the tube that monitors the concentration inside the mask is called the 'sample' tube.

1. Remove the sampling end of the twin tube assembly from fit test enclosure, leaving the other end connected to the PortaCount® to prepare software for fit testing.

2. Open the FitPlus™3 software (Figure 26) to choose or create a new database where results will be saved.

Figure 26: FitPlus™3 Software Icon

3. After double selecting the FitPlus™3 icon a window will appear that is used to open either an existing database or to create a new database.

   a. To open an existing database select "BROWSE" and choose by selecting desired database and selecting "OPEN" after selection.

   b. Alternately, to create a new database, select "CREATE NEW" and then "BROWSE" to enter a name of database in the name field and select the desired directory. Upon creation and saving of the new database, this database will be the active database used to save to upcoming fit test results.

4. Select the default or desired database and select OK.

5. The main screen of FitPlus™3 will be visible (Figure 27) and a window to perform daily checks will appear (Figure 28A).

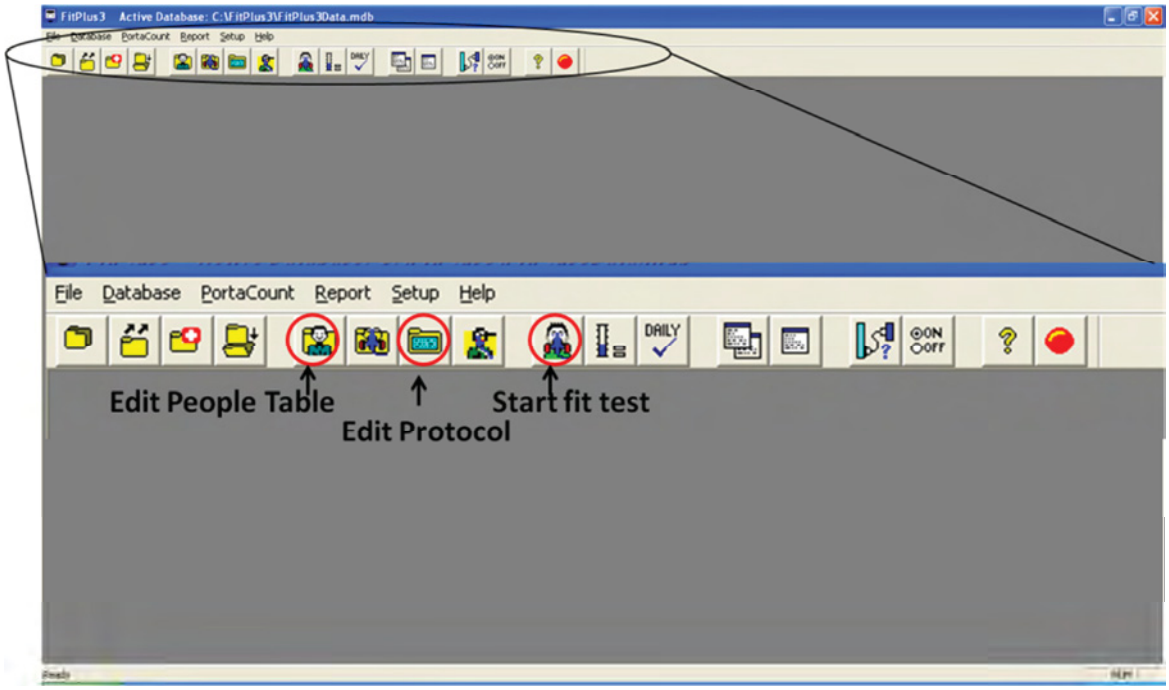

Figure 27: FitPlus™3 Main Screen

6. The software will then ask if you'd like to run the Daily Checks.

   a. Select Yes, if this is the first use of the day (or for troubleshooting), and then follow the instructions.

   b. The first test (Particle Check) will be a monitoring of the particle concentration (i.e. the ambient/challenge concentration) to ensure it is sufficiently high for the daily checks to continue (Figure 28A). Note: this check does not ensure there is sufficient concentration to measure a high PF.

   c. Next there will be a Zero Check. You will be instructed to attach a HEPA filter to the clear Sample Tube. Do so, and then press START (Figure 28B).

   d. Finally, the software will perform the maximum fit factor check automatically. The HEPA filter must remain on the Sample Tube for this test. It is being used to simulate a perfectly fitting respirator, while the unit is also testing an internal switching valve. A fit factor result of at least 50,000 is required to pass this test.

   e. If the check has not passed, refer to Annex H for cleaning.

7. After check is complete press "Exit" as shown in Figure 28C.

8. Remove HEPA filter and replace adapter

9. Insert hoses back into enclosure.

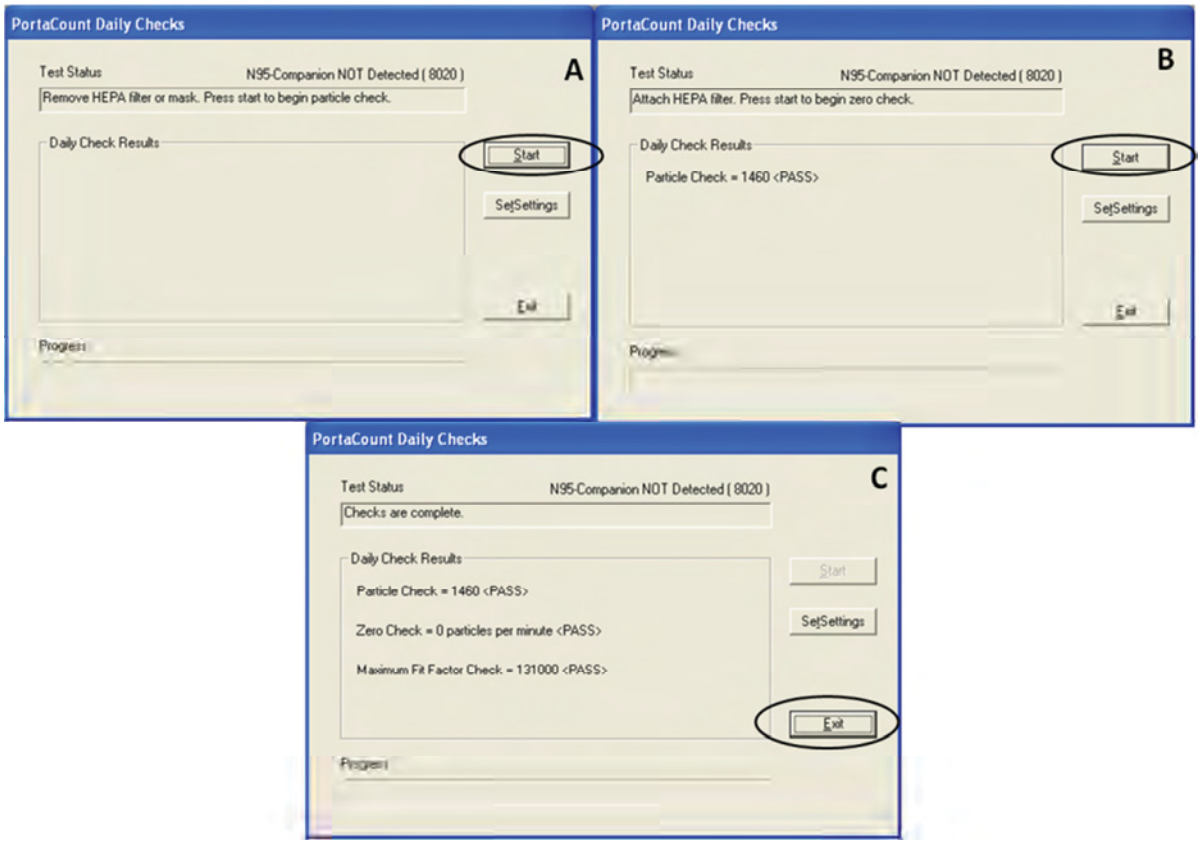

Figure 28: Performing daily checks

10. Once the daily check is complete, the "Select a Person" window will open to start a fit test. If activity routine is already programmed in software continue with step 16. Otherwise press "Exit" and continue with step 11 to change or insert a new activity routine.

11. To change or insert a new activity routine press the "Edit Protocol" icon as shown in Figure 27: FitPlus™3 Main Screen.

12. Select "NEW", enter a name for the new activity routine (protocol) below "Protocol Name", and enter all activities to be performed during the protocol as shown in Figure 29.

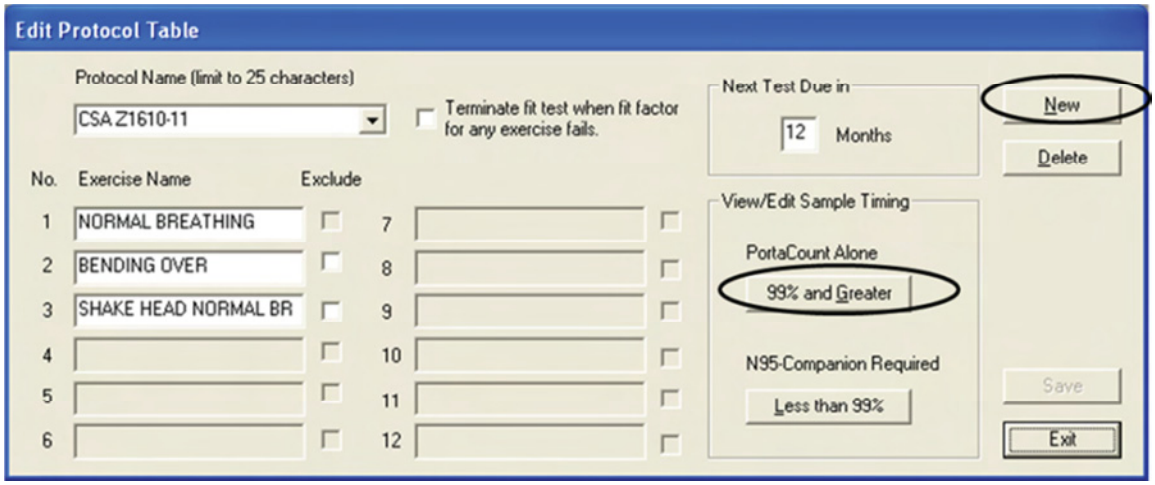

Figure 29: How to change or create a new activity routine

13. Select the "99% and Greater" button to view and set sample timing (Figure 30).

14. Confirm that mask purge time is 15 seconds, mask sample time for every activity is 30 seconds, ambient sample is 5 seconds and ambient purge is 10 seconds.

15. Press the "Save" and "Exit" button to save the sample timing and exit window.

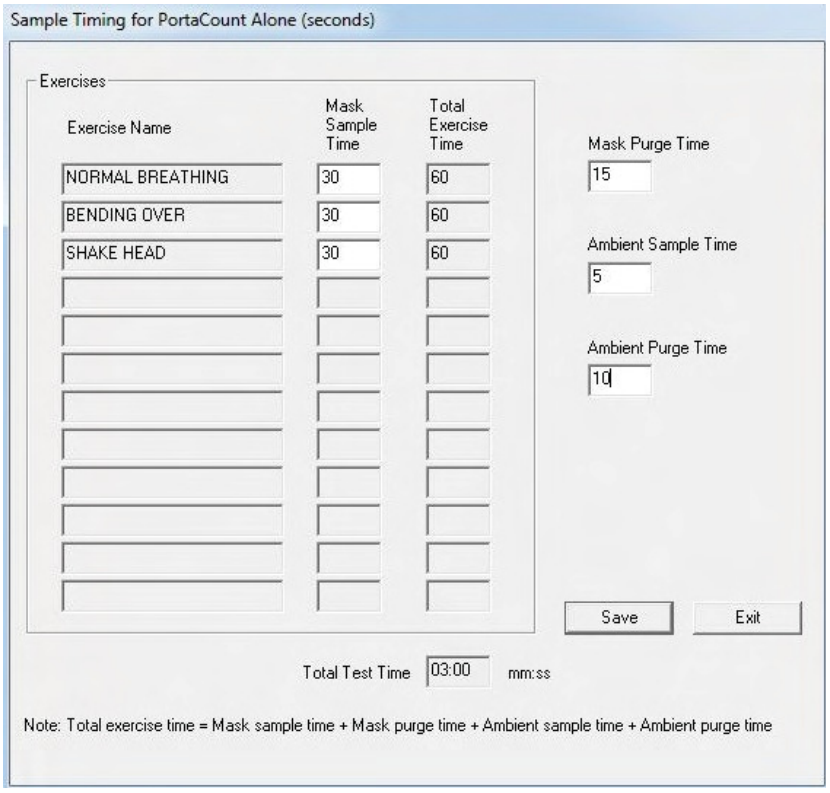

Figure 30: Viewing and setting of sample timing

16. Select "Save" and "Exit" on protocol table to exit protocol table.

17. A new window “Change Default Protocol” (Figure 31) will open to save the current protocol as the default protocol. Choose “Yes” to make it your default protocol and choose “No” otherwise.

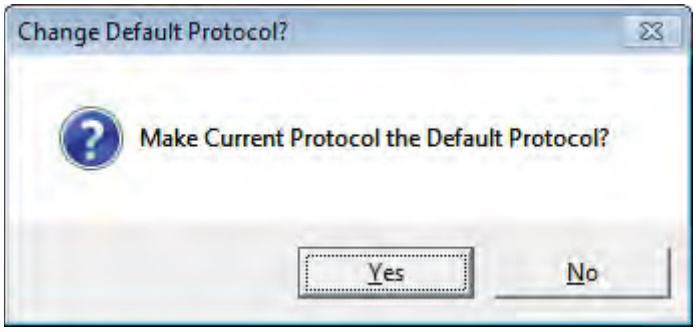

Figure 31: Changing of default protocol settings

18. To insert information about a new person to be fit tested, select the “Edit People Table” button on the main screen (Figure 27) and enter the information prior to the fit test. Select “NEW” and enter the last name, first name, and ID number of the person being fit tested.

    NOTE: CUSTOM 1-4 fields can be used to insert environmental conditions (temperature and relative humidity) and/or personal protective equipment worn if appropriate (see FitPlus™ software user manual for instruction on changing field labels).

19. It is convenient to enter this information prior to the fit test session so that individuals can be selected from a pre-entered list. However, this window will also open when a fit test is going to be started.

20. Once the protocol and “People Table” are saved, the PortaCount® and software are ready to start the fit testing.

C.3 Preparing candidate and performing fit test

1. Complete the portion of the record sheet capturing the information on the candidate including name, ID number, name of tester, PPE to be tested, and date of test.

2. Conduct a thorough visual inspection of the candidate’s mask before donning, checking for damage.

3. Use a water removal tool (syringe, not supplied) to suck out any water that may be present in the drinking device of the mask (Figure 32).

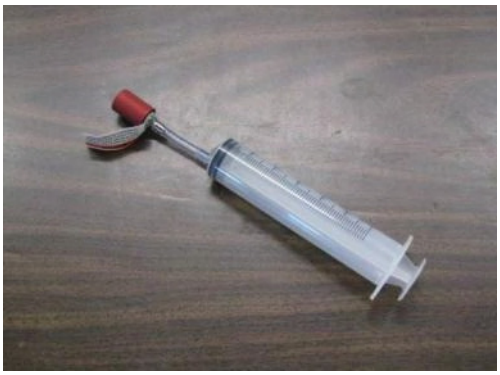

Figure 32: A syringe with a tube attached to the drinking device adapter that is used to aspirate water from the drinking device

4. Remove the drinking tube straw from the inside of the gas mask and set aside (Figure 33).

Figure 33: Mask with drinking tube straw present (left) and removed (right)

5. Affix appropriate fit-test canister(s) to mask.

6. Ensure candidate is not chewing gum, and has not had anything to eat or drink (except water) for at least 30 minutes prior to the fit test.

7. If candidate is a smoker, ensure candidate has not smoked for at least 30 minutes prior to the fit test.

8. Instruct candidate on fit testing activity routine used during the upcoming fit test.

9. Have candidate correctly don the respirator according to section 4.7 (PC4) or according to manufacturer's instructions.

10. Visually inspect proper donning of mask and look in particular for large gaps between seal and skin or hair located underneath the seal. If warranted, change the mask size to solve problems.

11. Have candidate wear respirator without talking for at least 5 minutes before starting the fit test to clear out spurious particles inside mask.

12. Start to prepare PortaCount® with all required information for fit testing.

13. Press the “Start Fit Testing” button on the main screen on FitPlus™3 (Figure 27).

14. The window “Select a Person” will open as shown in Figure 34.

15. Either, select a person from the “People List” if person is already entered in database, or press the “NEW” button to insert the last name, first name, and ID number of the person being fit tested.

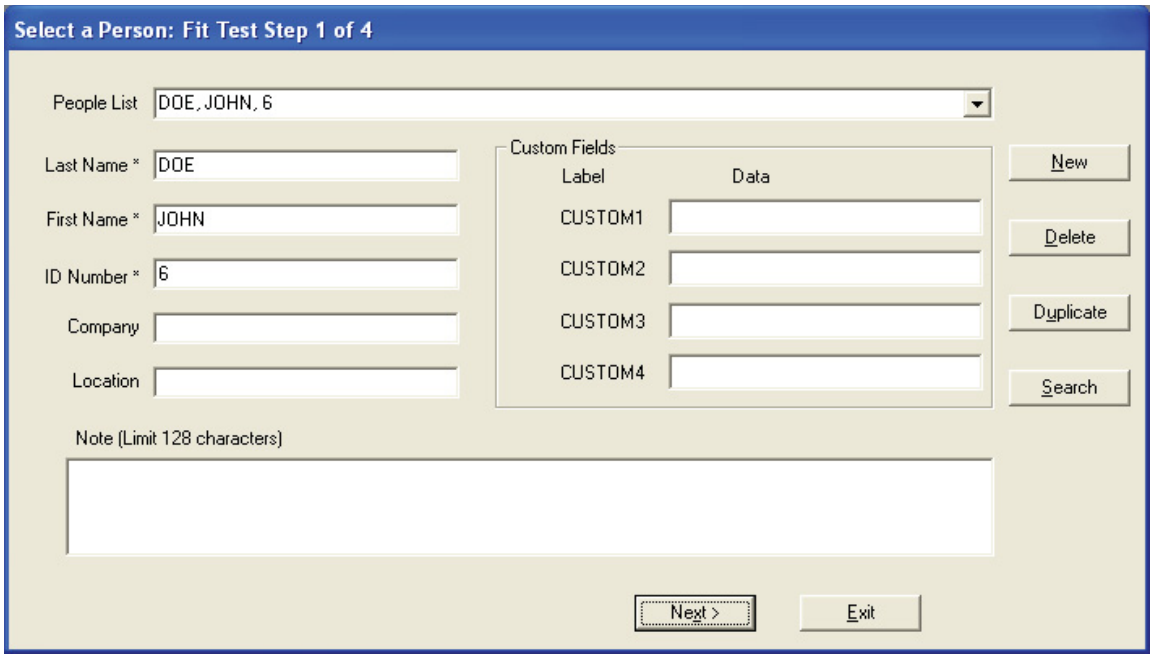

Figure 34: Step one of fit testing – to insert information about the person being fit tested

16. Press “Next” after data have been inserted.

17. A new window “Select a Respirator” will open as shown in Figure 35.

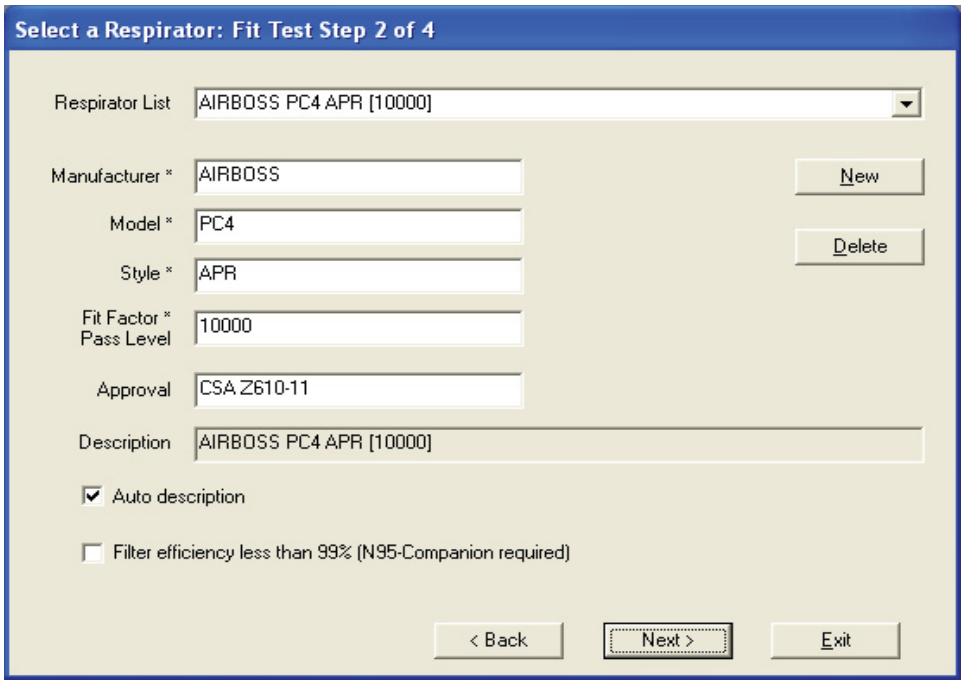

Figure 35: Step two of fit testing information – to insert information about respirator being used for fit test

18. Either select an existing respirator type by choosing one from the respirator list, or select "NEW" to create a new type of respirator and insert manufacturer, model, style, fit factor pass level, and approval for respirator.

19. Select "NEXT" once information has been inserted.

20. A new window "Protocol Information" will open as shown in Figure 36.

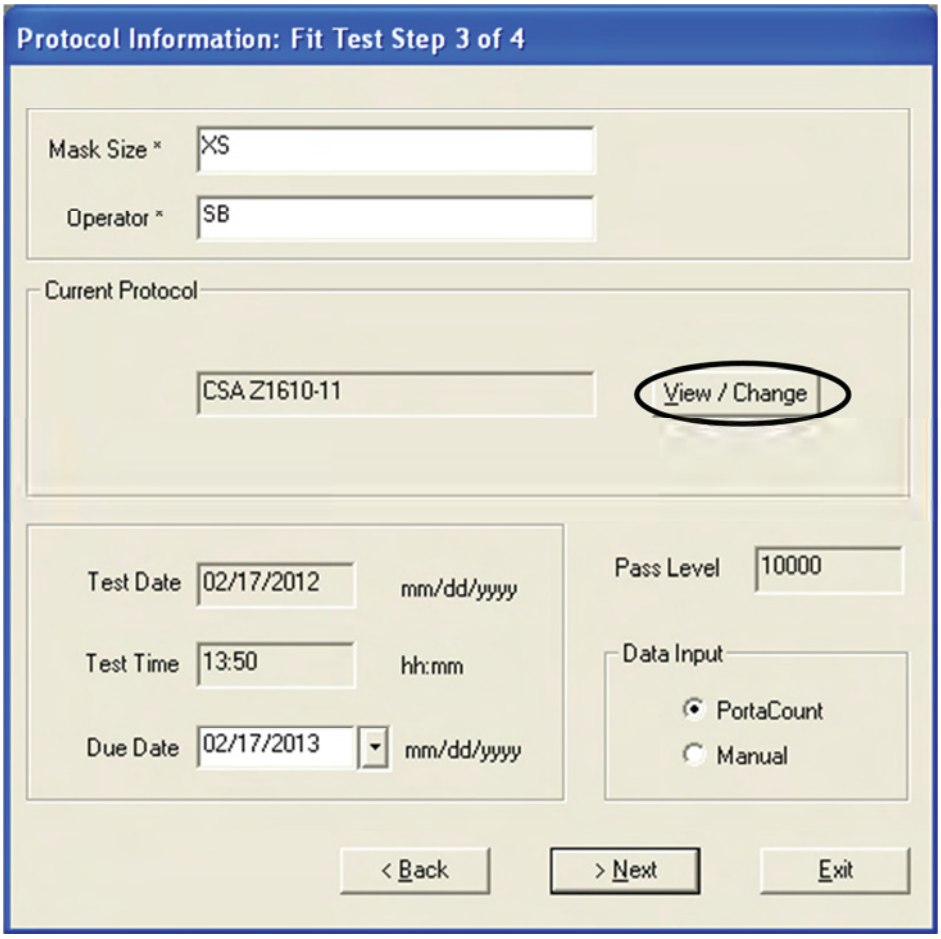

Figure 36: Step three of fit test information – to select an activity routine

21. Enter the mask size of individual to be fit tested as well as the name of the operator conducting the fit test.

22. Select "View/Change" to change a protocol or assign a previously entered protocol as default protocol (see Figure 36)

23. A new window to select the protocol will open (Figure 37).

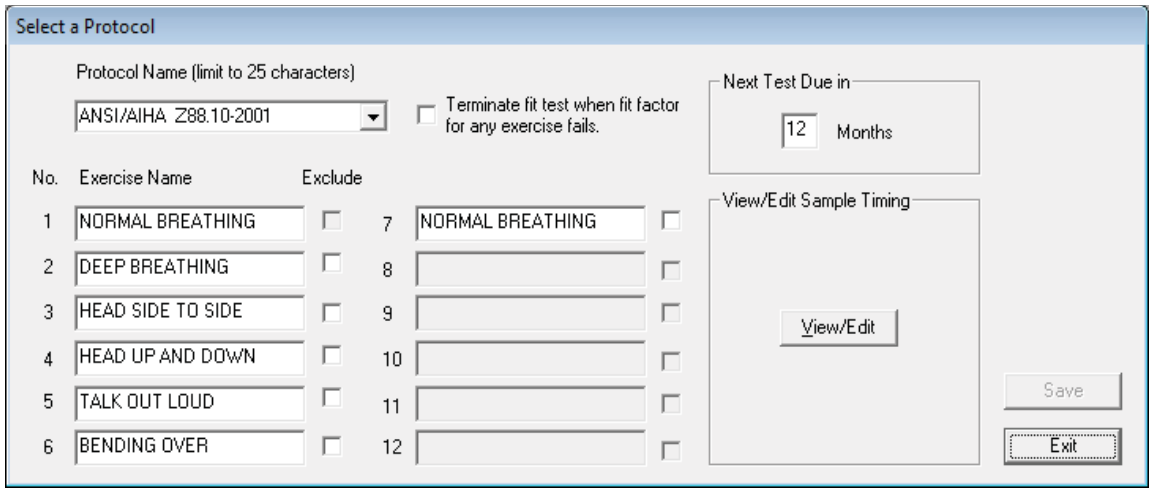

Figure 37: Selecting a protocol for the fit testing

24. Select the desired protocol using the drop-down menu below "Protocol Name" and press "Exit".

25. The "Protocol Information" window (Figure 38) will open to discard or keep changes.

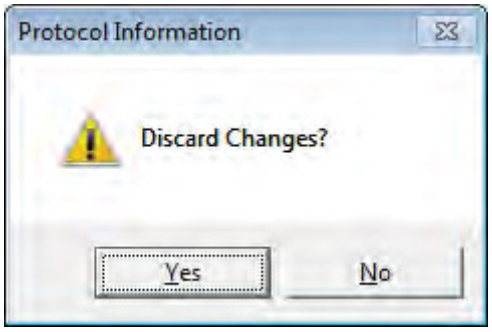

Figure 38: Protocol information window

26. If "NO" is selected, the program will choose the newly selected protocol and goes back to fit test step 3 of 4 window (Figure 36). If "YES" is selected a new window will open to make the newly chosen protocol the default protocol.

27. Fit test step 3 of 4 window (Figure 36) will appear again.

28. Press "Next" once all information has been inserted.

29. A new window "Run Test" will open (Figure 39) to start fit test.

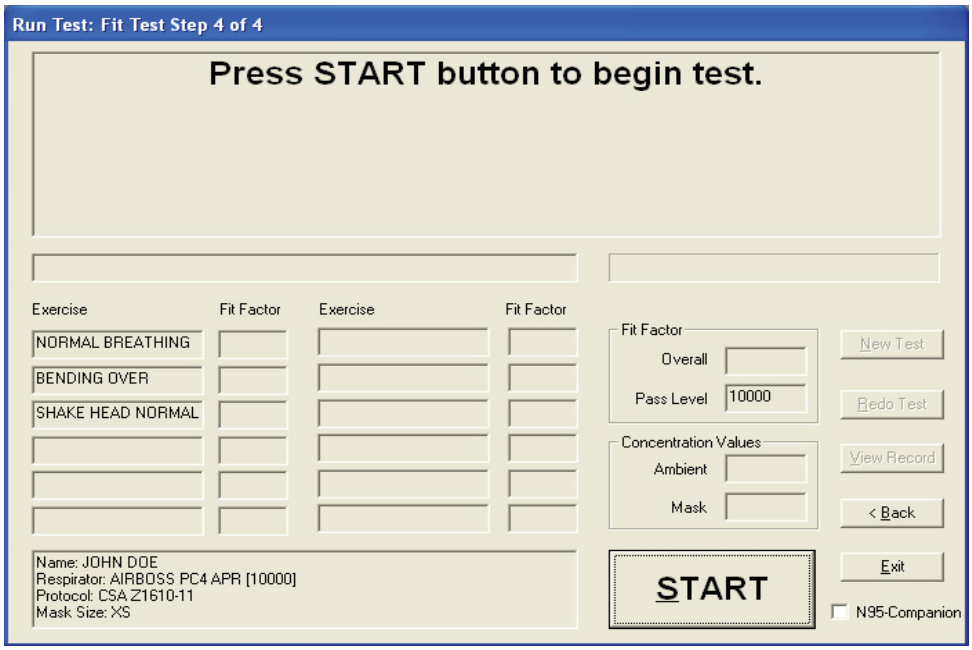

Figure 39: Start of fit testing

30. Once the minimal time period of five minutes has elapsed, escort the candidate into the fit test enclosure and connect the drinking device of the respirator to the fit test adapter of the PortaCount® sampling line tube.

31. Open the PortaCount® menu and select "Real Time" to show the "Real Time Fit Factor Display" (Figure 40). Immediately, the display shows an ambient concentration reading as well as a real time mask concentration reading. Note that the ambient reading can be updated by selecting the "Refresh" button.

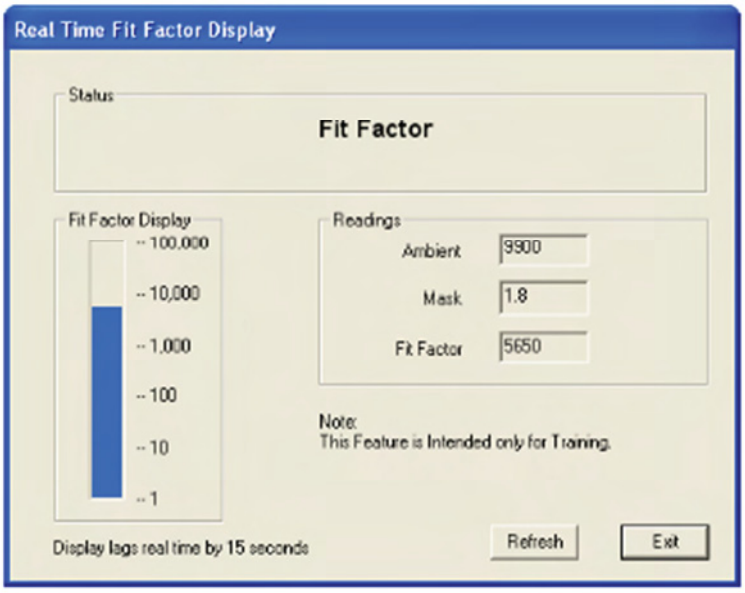

Figure 40: Measuring the ambient concentration in the fit test enclosure

32. A particle concentration of >40,000 particles/cm^3 (for PF requirement 500 or 10,000) or a particle concentration of >60,000 particles/cm^3 (for PF requirement 20,000) inside the tent enclosure should be established. It is recommended to use a concentration of <100,000 particles/cm^3 to reduce clogging of instrument when used for an extended period of time. Do not exceed a concentration of 150,000 particles/cm^3.

33. If necessary adjust generator output using the set screw located at the top of the generator according Annex A.

34. Press "EXIT" on the "Real Time Fit Factor Display" window after the appropriate concentration has been established.

35. Instruct candidate to refrain from talking unless instructed to do so, and to follow the operator's instructions.

36. Press "START" button to start fit test.

37. Instruct the individual that the fit test has started and the activity to perform. Communicate with the test participate when needed to proceed to the next activity. Software will indicate which activity is active. Figure 41 shows an example of a QNFT routine.

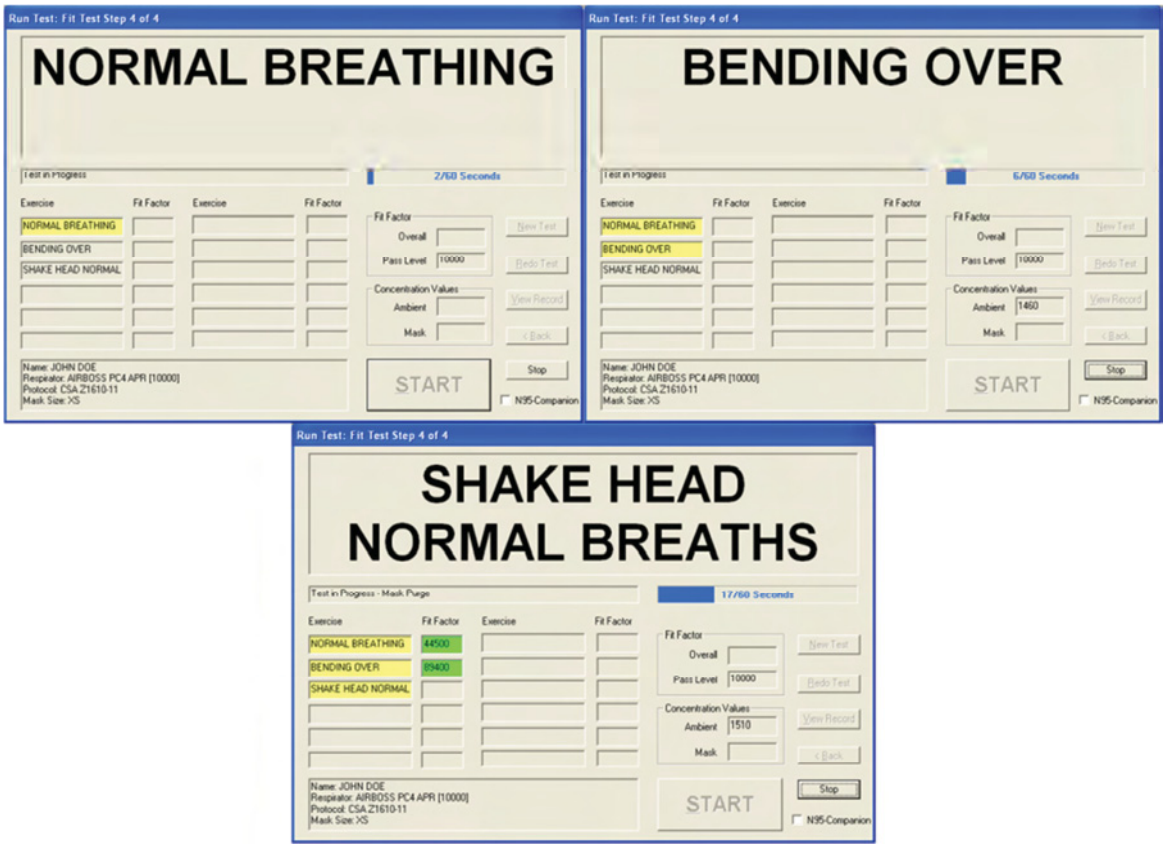

Figure 41: Example of a QFNT activity routine

38. At the end of the activity routine, a window will open that indicates that the fit test has been completed as shown in Figure 42. The window will indicate a pass or fail for the fit test. The fit factor for each activity and for the overall activity routine will be observed. Green fields indicate acceptable protection factors values while red fields indicate failed values. It is the overall PF that

is used to judge the test, but individual activities that fail may be used to diagnose particular issues with the respirator fit.

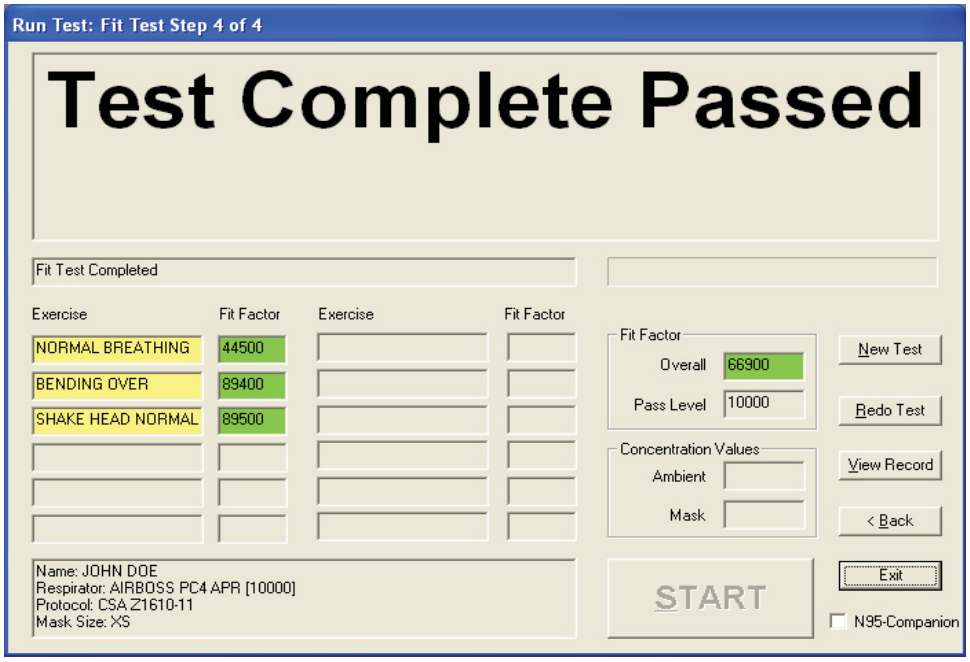

Figure 42: Completed fit test

39. Instruct the candidate to disconnect the adapter from the sampling tube and to step outside the tent enclosure. (It may be preferable to wait if more than one candidate is testing at once).

40. Record fit test results and enclosure concentration onto record sheet.

41. Instruct candidate to properly doff the respirator if fit test passed. Once candidate has completed testing with a given respirator, replace the drinking tube straw on the respirator and remove fit-test canister.

42. If the candidate failed the fit test, perform trouble-shooting techniques as outlined in the body of the document and Annex G.

43. After fit testing has been completed for all required people, refer to Annex D.2 to export fit test data from the FitPlus™3 software.

44. Close FitPlus™3 Software.

45. Put a HEPA filter on the white (sample) tube of the twin tube assembly and press “COUNT” on the PortaCount® to observe particle count (should go down to 0 in a few seconds). Run PortaCount® for a few minutes to clear out remaining particles.

46. Switch the alcohol wick with the storage cap and put all equipment back into the case.

47. For general maintenance activities, refer to Annex H.

Annex D How to program an activity routine in FitPlus3™ software

1. To select an activity routine to be the default protocol, to edit an existing protocol or to create a new protocol, press the "edit protocol" icon as shown in Figure 43.

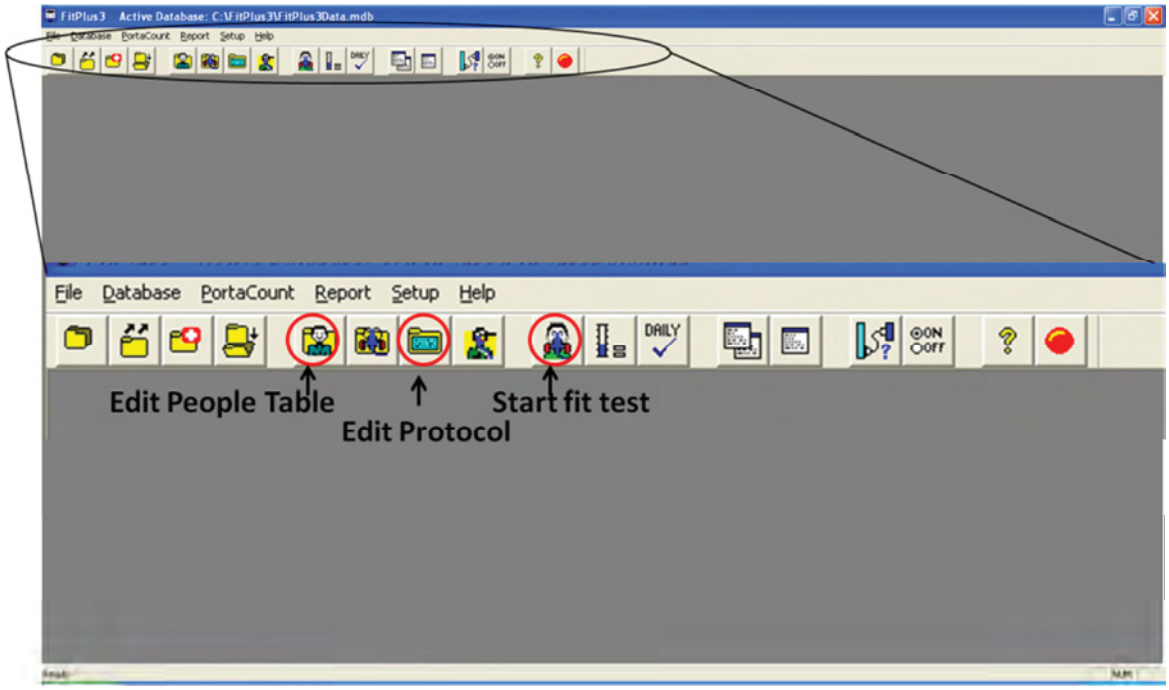

Figure 43: FITPlus3™ main screen

2. The "Edit Protocol" window will open (Figure 44).

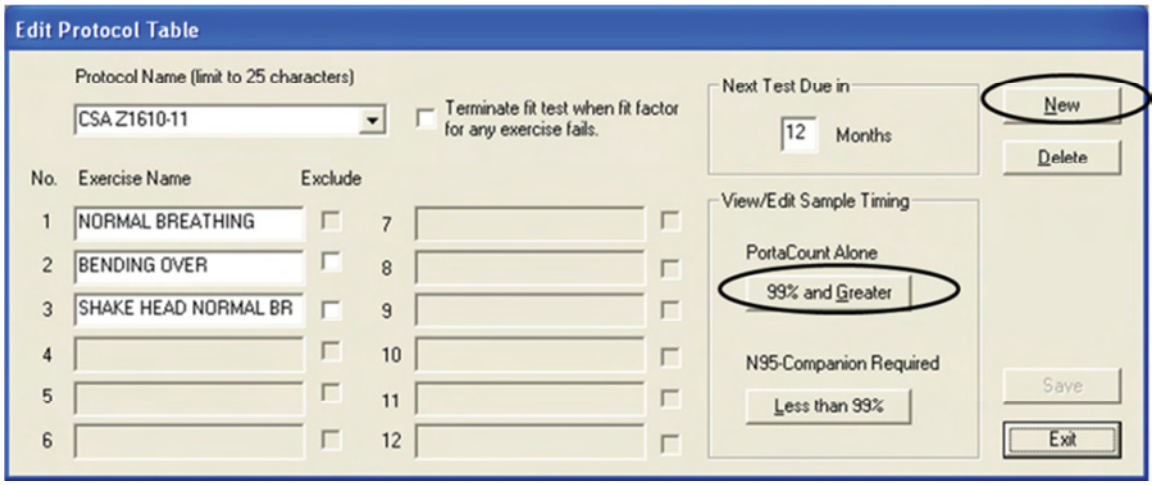

Figure 44: How to change or create a new activity routine

D.1.1 Setting Default Protocol

1. Select the desired activity routine from the drop-down menu and press “Save”.

2. A pop-up window to make the selected protocol the default protocol will appear as shown in Figure 45.

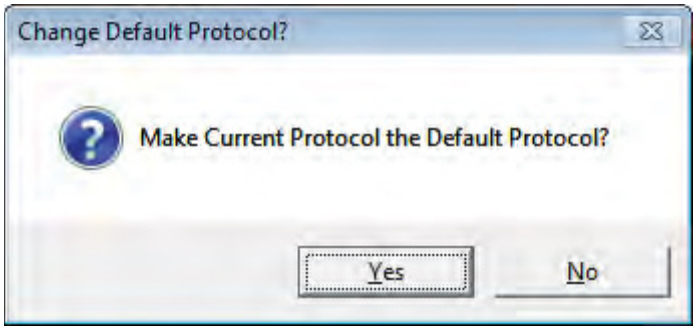

Figure 45: Changing of default protocol settings

3. Select “Yes”. The selected protocol will be the default protocol used for the upcoming fit testing.

D.1.2 Editing a Protocol

1. To edit an existing protocol, select the protocol from the drop down menu. Enter or change activities to be performed during the routine.

2. Select on the “99% or greater” button to view and set sample timing (Figure 46).

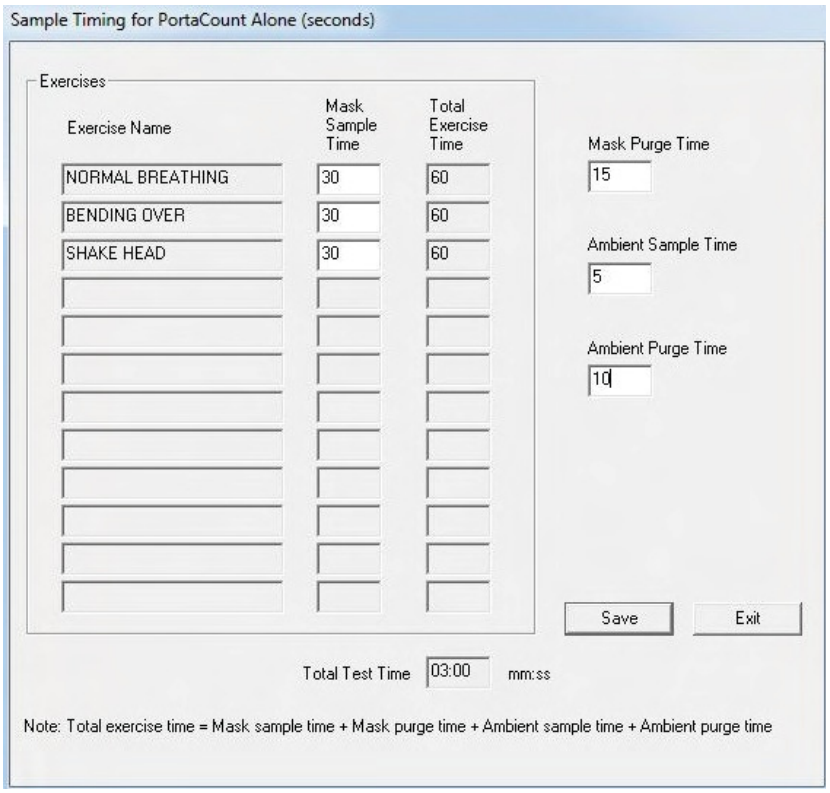

Figure 46: Sample Timing Window

3. Confirm that mask purge time is 15 seconds, and mask sample time for each activity is 30 seconds. Ambient sample is 5 seconds and ambient purge is 10 seconds.

4. Select "Save", then "Exit".

5. Select "Save" on the "Edit Protocol Table". A window to make the new protocol the default protocol will appear as shown in Figure 45.

6. Depending on your preference, select "Yes" or "No". Select "Yes" if protocol is to be used during the upcoming testing.

D.1.3 Creating a new Protocol

1. To insert a new protocol select on "NEW" button, enter a name for the new protocol below "Protocol Name", and enter all activities performed during the activity routine as shown in Figure 44.

2. Select the "99% or greater" button to view and set sample timing.

3. Set mask purge time to 15 seconds, mask sample time for every activity to 30 seconds, ambient sample to 5 seconds, and ambient purge to 10 seconds.

4. Press the "Save" and "Exit" button to save the sample timing and exit window.

5. A pop-up window will open to save the current protocol as the default protocol (Figure 45). Choose "Yes" to make it your default protocol and choose "No" to not make it your default program.

D.2 Export of Fit test data in FitPlus3™ software

D.2.1 Excel Format

1. To export data from the currently active database in excel format, go to main screen and select "Database" tab, "Export" and then select "Excel format".

2. Window "Export Data in Excel Format" will appear (Figure 47).

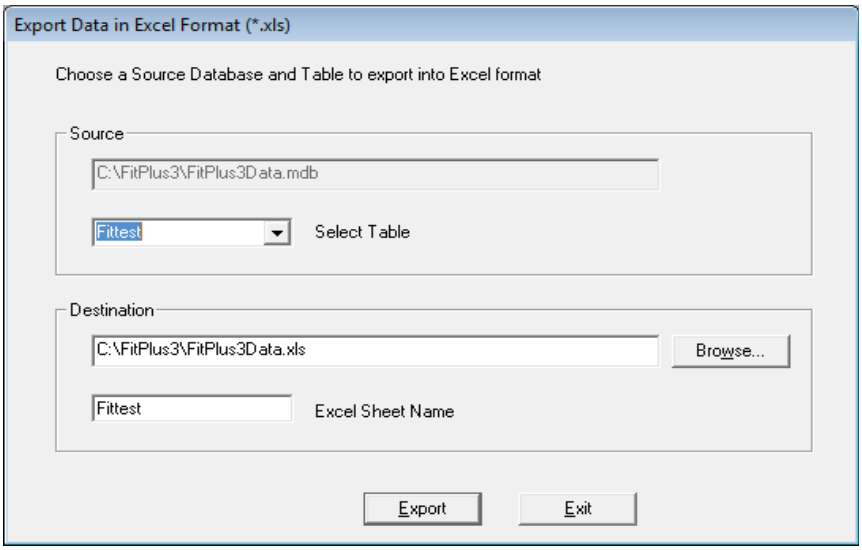

Figure 47: Export of data in Excel format

3. Select the "Fittest" table to be exported and also select "Browse" to choose the destination directory.

4. Enter a name for your excel file.

5. Select "Export".

6. A window that the database table has been successfully exported in Excel format will appear (Figure 48).

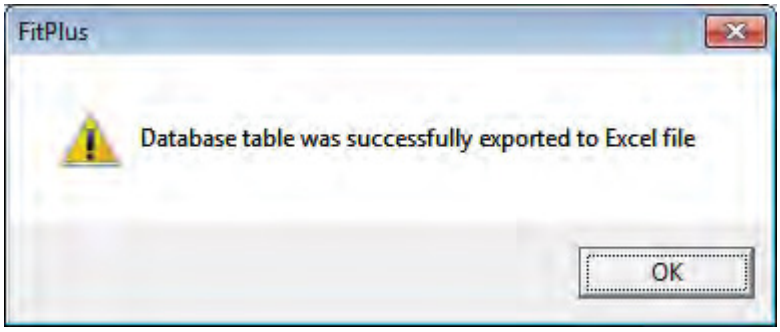

Figure 48: Successful creation of the exported database in Excel format

D.2.2 Comma Separated Value (CSV) Format

1. To export data from the currently active database in comma separated value (CSV) format, go to main screen and select on the database tab, export and then select CSV format.

2. The window "Export Data into Comma Separated Value (*.CSV) Format" will appear (Figure 49).

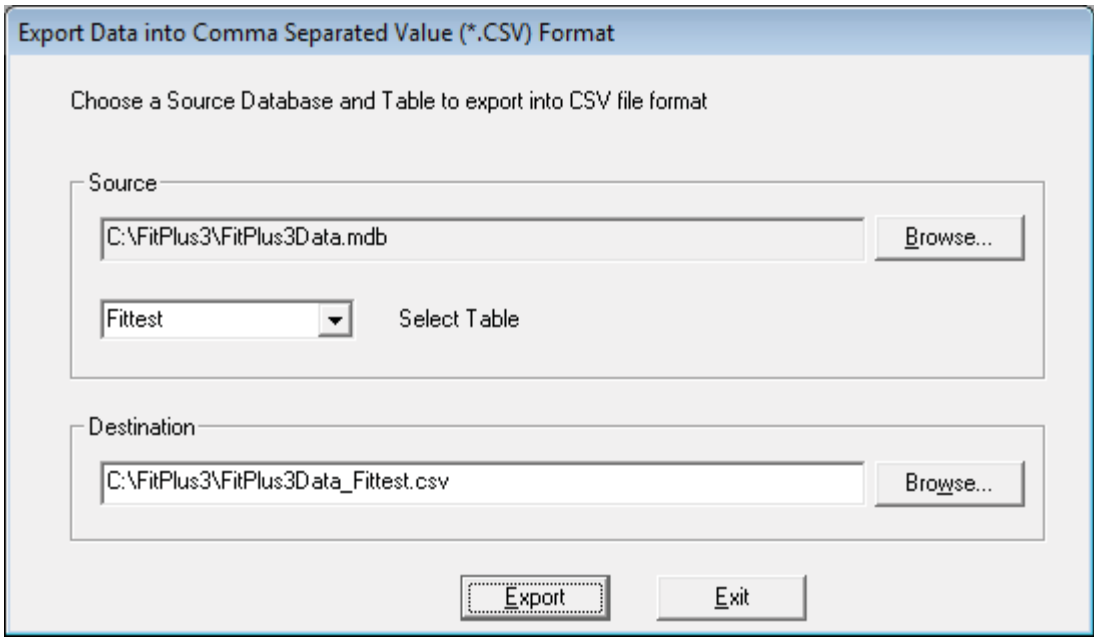

Figure 49: Export of data in comma separated value format

3. Select the "Fittest" table to be exported and select "Browse" to choose the destination directory.

4. Enter a name for your excel file.

5. Select "Export".

6. A window will appear stating that the database table has been successfully exported in CSV format (Figure 50).

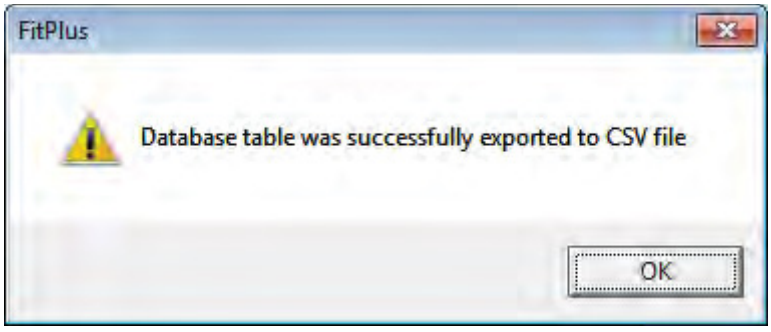

Figure 50: Successful creation of the exported database in CSV format

7. Press "Exit".

D.3 View and print fit test records

1. Select “Report” from the tool bar menu.
2. Then select “Select Report” (Figure 51).
3. Now select “Fit Test Report”.
4. Choose “View Report”.
5. You may now scroll through all saved fit test reports in this particular database. You may also print if necessary one or all by choosing the “Print” or “Print All” options.

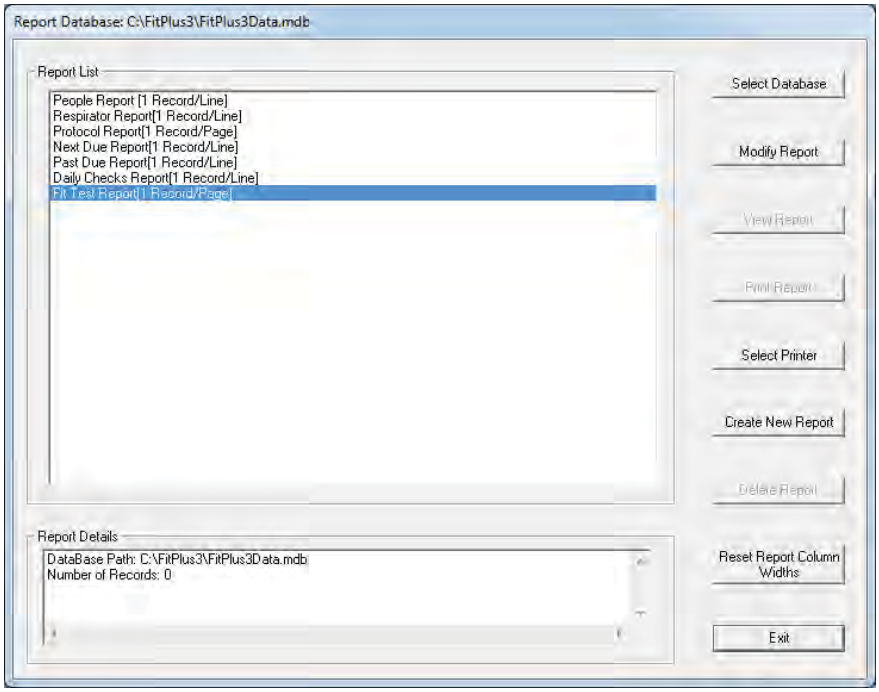

Figure 51: Report database window

Annex E Quantitative fit testing using PortaCount® Pro 8030 and 8038 [new model in 2008]

E.1 Set-up and operation

1. Remove the PortaCount® device, alcohol wick, power cord, twin-tube assembly, and data cable from the carrying case and place on a table setup in front of one of the windows of the fit test enclosure (Figure 52).

Figure 52: PortaCount® 8030/8038 with accessories

2. Also remove the HEPA filter and fit test adapter from the case and place in close proximity to the above equipment.

3. Place a laptop/PC together with a power cord in close proximity as well.

4. Connect power cord into back of PortaCount® and plug into a grounded outlet or power bar.

5. Remove the storage plug from the PortaCount® by twisting the cap counter clockwise, according to Figure 53A.

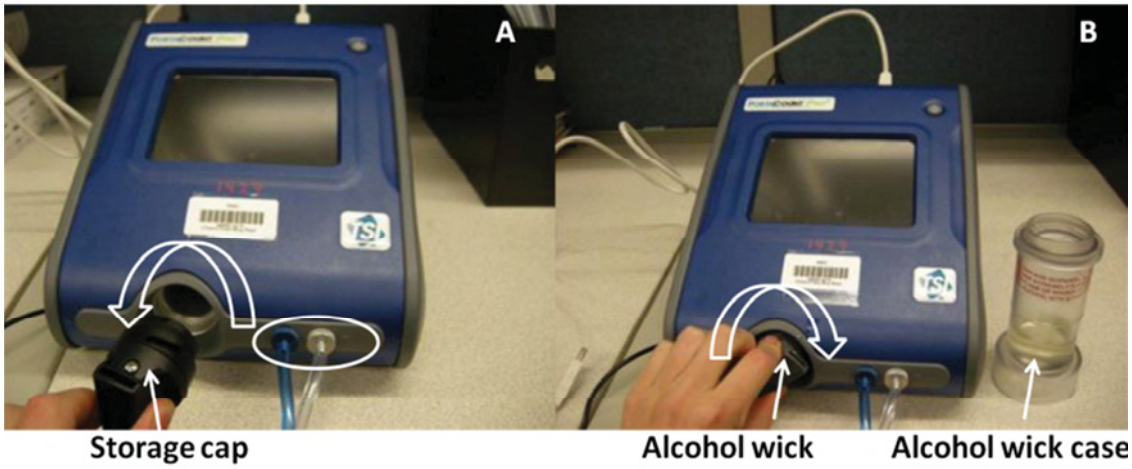

Figure 53: Storage plug inserted in cavity of PortaCount® 8020 (picture A), and alcohol wick being inserted in cavity (picture B)

6. Insert the wick in the cartridge cavity, secure the alcohol cartridge by gently twisting clockwise to lock cartridge into place, according to Figure 53B.

7. Place storage cap onto alcohol cartridge case.

8. Turn on PortaCount®.

9. Connect the blue and clear twin tube assembly (refer to Figure 53) to the corresponding ports on the front of the PortaCount®.

10. Attach appropriate drinking device adapter (Figure 54) to the clear (longer) tube.

Figure 54: Drinking device adapter attached to the white tube of the twin tube assembly

11. Turn on the computer.

12. Connect PortaCount® to the computer via the USB cable (USB-A connects to laptop and USB-B connects to PortaCount® as shown in Figure 55).

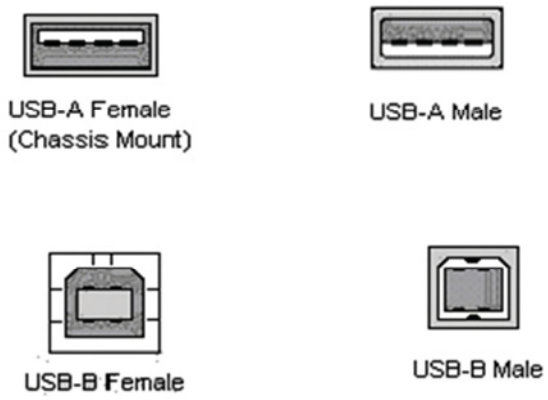

Figure 55: USB cable diagram to connect computer with PortaCount®

E.2 Preparing to fit test using FITPro™ Software

1. For reference in this section, for the PortaCount® system, the tube that monitors the outside concentration is called the 'ambient' tube, and the tube that monitors the concentration inside the mask is called the 'sample' tube.

2. Open FitPro™ Software (Figure 56).

Figure 56: FitPro™ Software Icon

3. After double selecting the Fitpro™ icon, a window will appear (Figure 57) that is used to open either an existing database or to create a new database.

   a. To open an existing database select "Browse" and choose by selecting desired database and selecting "Open" on directory window and "OK" after selection to make the chosen database the active database used to save results.

   b. Alternately, to create a new database, select "Create New" and then "Browse" to enter a name of the database and select the desired directory. Select "Save", "Create", and then "OK" once the window appears to let you know that the creation of the new database has been successful.

4. Press "Exit".

5. To make the newly created database active, press "Browse" in the "Change Active Database" window (Figure 57) and select the desired database within the directory. Press "Open" and then "OK" to exit the window. The selected database will now be the active database used to save the upcoming fit test results.

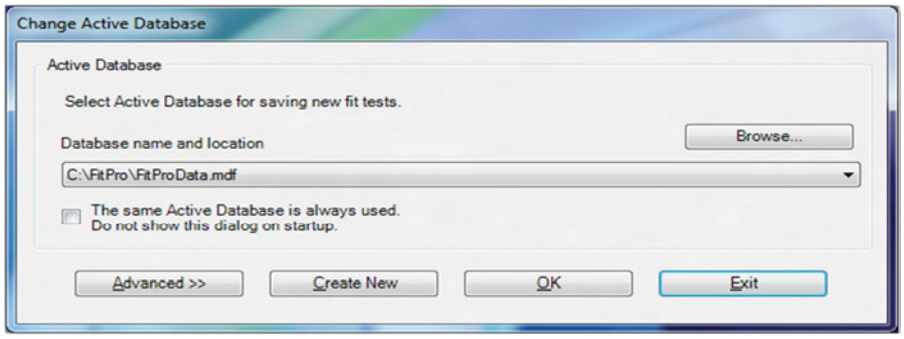

Figure 57: Create or open an active database

6. The main screen of FitPro™ will be visible (Figure 58) and a window to perform daily checks will appear. Refer to F.3 *Communication of PortaCount® with FitPro™ Software* in the event the PortaCount® does not communicate with the FitPro™ software.

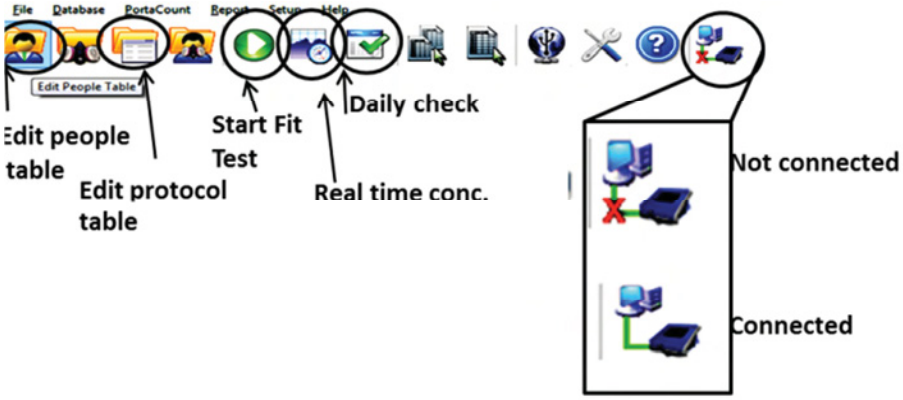

Figure 58: Main screen of FitPro™ software

7. Select "Yes" on the daily checks screen and follow the instructions showing up on subsequent windows.

8. If there was one attached, remove HEPA filter from sample or ambient tube.

9. Press "Start" (Figure 59A).

10. Attach HEPA filter to the sample (clear) tube when message to do so appears below "Test Status", as shown in Figure 59B.

11. Press "Start" again to perform zero filter check and maximum fit factor check.

12. If the check has not passed, refer to Annex G

13. After check is complete press "Exit" as shown in Figure 59B. Remove HEPA filter and replace drinking tube adapter; insert hoses into enclosure.

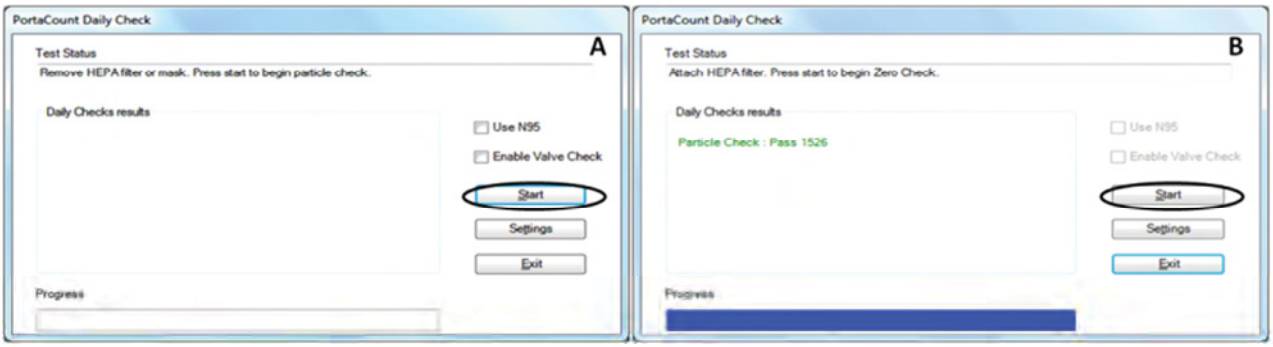

Figure 59: Performing daily checks

14. Put twin tube assembly in fit test tent enclosure to prepare to measure particle concentration.

15. Press the real time concentration icon on main screen (Figure 58) to measure particle concentration in fit test enclosure. A window (Figure 60) will open. Select "CONCENTRATION". The graph below will present the ambient particle concentration inside the enclosure.

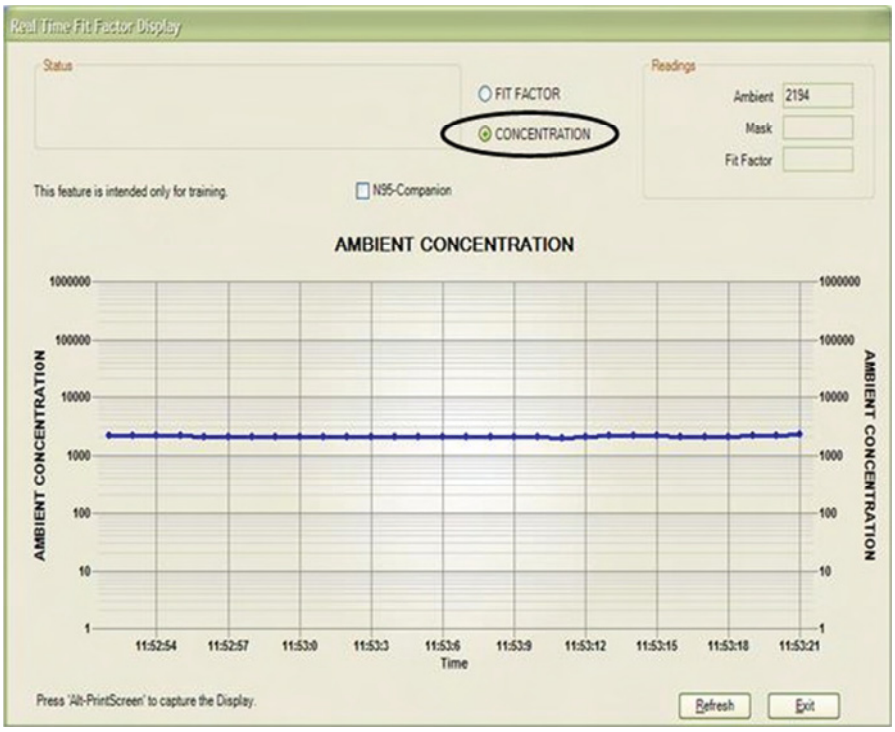

Figure 60: Measuring the ambient concentration in the fit test enclosure

16. A particle concentration of >40,000 particles/cm^3 (for PF requirement 500 or 10,000) or a particle concentration of >60,000 particles/cm^3 (for PF requirement 20,000) inside the tent enclosure should be established. It is recommended to use a concentration of <100,000 particles/cm^3 to reduce clogging of instrument when used for an extended period of time. Do not exceed a concentration of 150,000 particles/cm^3.

17. If necessary adjust generator output using the set screw located at the top of the generator according Annex A.

18. Press “EXIT” on the real time fit factor display window after the appropriate concentration has been established.

E.3 Preparing candidate and performing fit test

1. Complete the portion of the record sheet capturing the information on the candidate including name, ID number, name of tester, PPE to be tested, and date of test.

2. Conduct a thorough visual inspection of the candidate’s mask before donning, checking for damage.

3. Use a water removal tool (syringe, not supplied) to suck out any water that may be present in the drinking device of the mask (Figure 61).

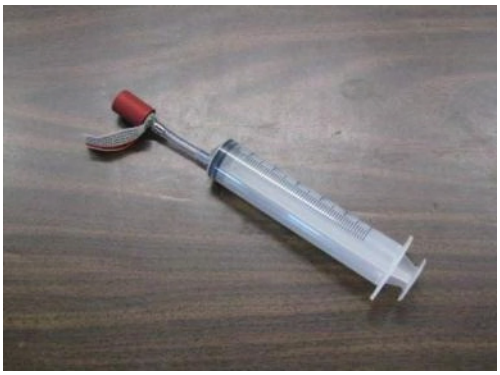

Figure 61: A syringe with a tube attached to the drinking device adapter that is used to aspirate water from the drinking device

4. Remove the drinking tube straw from the inside of the gas mask and set aside (Figure 62).

Figure 62: Mask with drinking tube straw present (left) and removed (right)

5. Affix appropriate fit-test canister(s) to mask.

6. Ensure candidate is not chewing gum, and has not eaten or drunk (except water) for at least 30 minutes prior to the fit test.

7. If candidate is a smoker, ensure candidate has not smoked for at least 30 minutes prior to the fit test.

8. Instruct candidate on fit testing activity routine used during the upcoming fit test.

9. Have candidate correctly don the respirator according to section 4.7 (PC4) or according to manufacturer's instructions.

10. Visually inspect proper donning of mask and look in particular for large gaps between seal and skin or hair located underneath the seal. If warranted, change the mask size to solve problems.

11. Have candidate wear respirator without talking for at least 5 minutes before starting the fit test to clear out spurious particles inside mask.

12. Start to prepare PortaCount® with all required information for fit testing.

13. Select the "Start Fit Test" button on main screen of FitPro™ as shown in Figure 58.

    NOTE: The activity routine used for the upcoming fit test has to be created and selected as the default protocol before start of fit test (refer to Annex F). Once the activity routine has been selected, continue.

14. The window "Run Test: Fit test step 1 of 4" will open as shown in Figure 63.

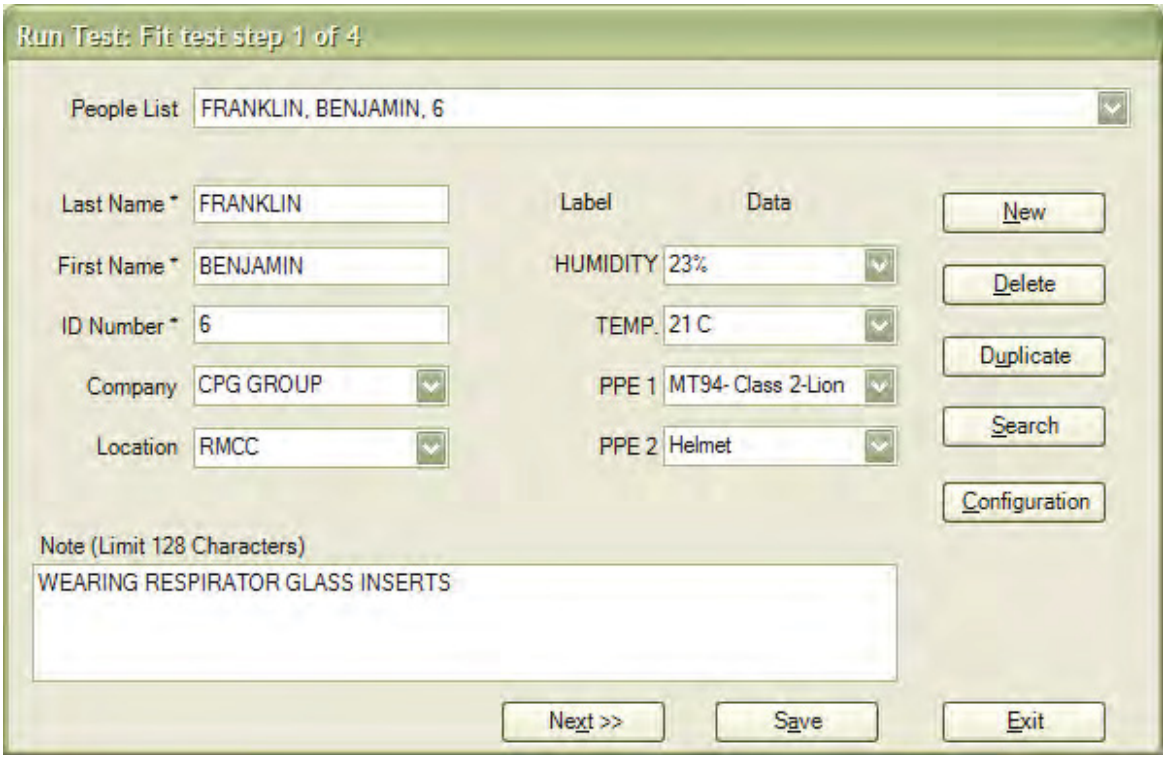

Figure 63: Step one of fit testing – to insert information about the person being fit tested

15. Either, select a person from the people list if person is already entered in database, or press the "New" button to insert the last name, first name, and ID number of person to be fit tested.

NOTE: Custom fields 1-4 can be used to insert environmental conditions (temperature and relative humidity) and/or personal protective equipment worn if appropriate. In Figure 63, Custom fields 1-4 have been labeled as humidity, temp, PPE 1 and PPE 2.

16. Press "Save" and "Next" after data have been inserted. NOTE: Once the information has been saved, the custom labels can be changed by pressing the "Configurations" button in the "Run Test: Fit test Step 1 of 4" window.

17. A new window "Run Test: Fit test step 2 of 4" will open as shown in Figure 64.

18. Either select an existing respirator type by choosing one from the respirator list or press "New" to create a new type of respirator and insert the manufacturer, model, style, fit factor pass level, and approval for the respirator.

    NOTE: Wear full PPE ensemble only for quantitative integration fit testing.

19. Select "Save" and "Next" once the appropriate information has been inserted.

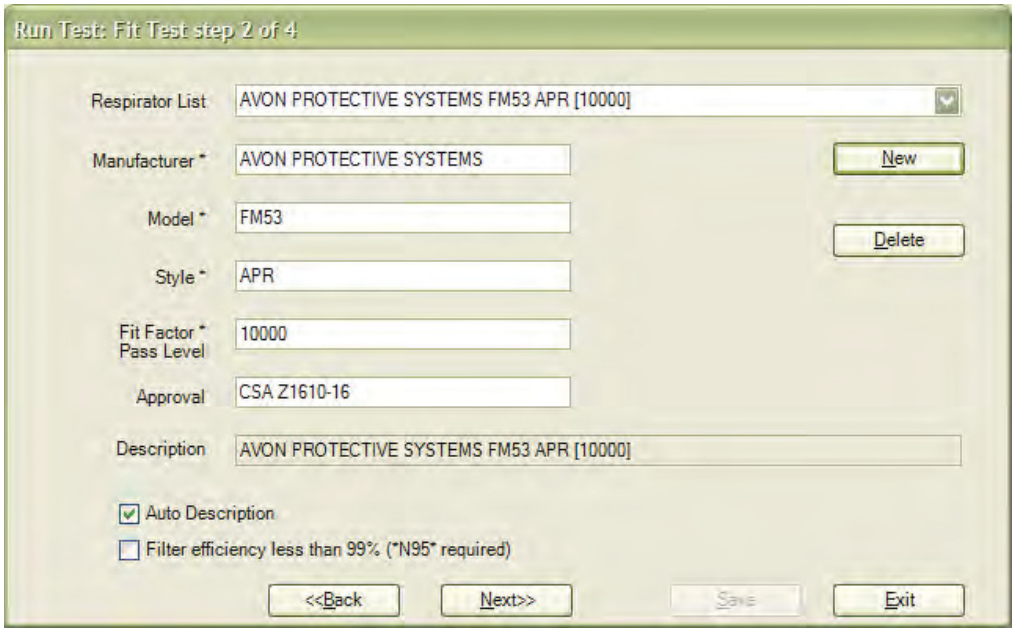

Figure 64: Step two of fit testing information – to insert information about respirator being used for fit test

20. A new window "Run Test: Fit Test step 3 of 4" will open as shown in Figure 65.

21. Insert mask size of individual to be fit tested and operator name conducting fit test.

22. Press "VIEW" (Figure 65) to view the currently selected activity routine previously inserted in the software.

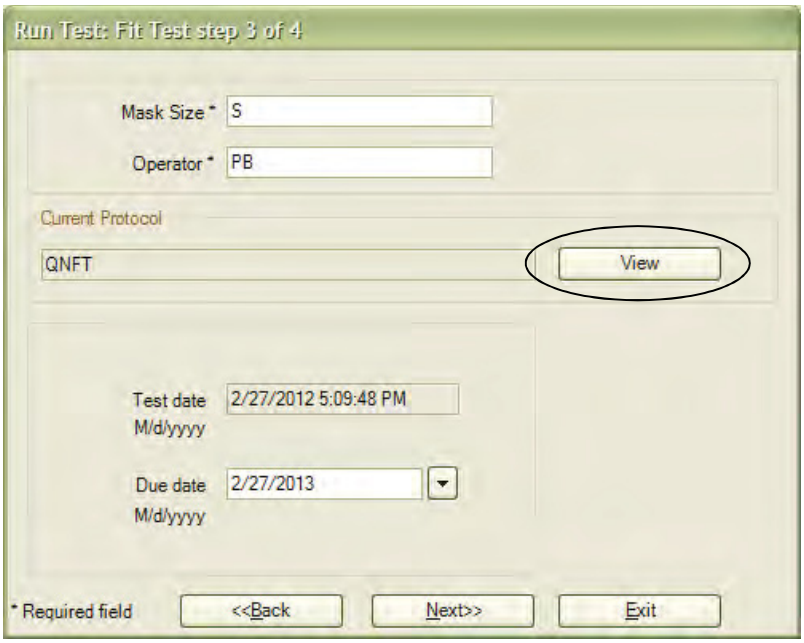

Figure 65: Step three of fit test information – to select an activity routine

23. A new window "Protocol" will appear. Press "Exit" after viewing the protocol to go back to the "Run Test: Fit test step 3 of 4".

24. If protocol is not the appropriate protocol, press "Exit" and refer to section Annex F to program a new activity routine or to make the desired protocol used for the fit testing the default protocol.

25. Press "Next" once all information has been inserted.

26. A new window "Run Test: Fit Test step 4 of 4" will open (Figure 66) to start fit test.

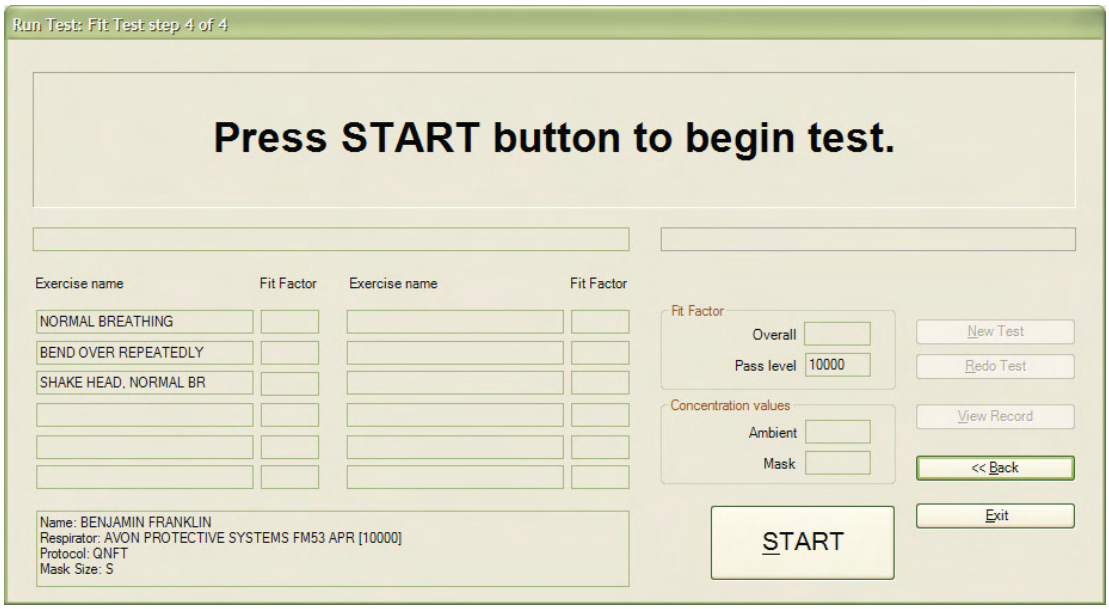

Figure 66: Start of fit testing

27. Once the minimal time period of five minutes has elapsed, escort the candidate into the fit test tent enclosure and connect the drinking device of the respirator to the fit test adapter of the PortaCount® sampling line tube.

28. Press the “Start” button to start fit test.

29. Instruct the individual that the fit test routine has started, which activity to do, and when to change activity. Software will indicate to the operator which activity should be active. Figure 67 shows an example of a QNFT routine.

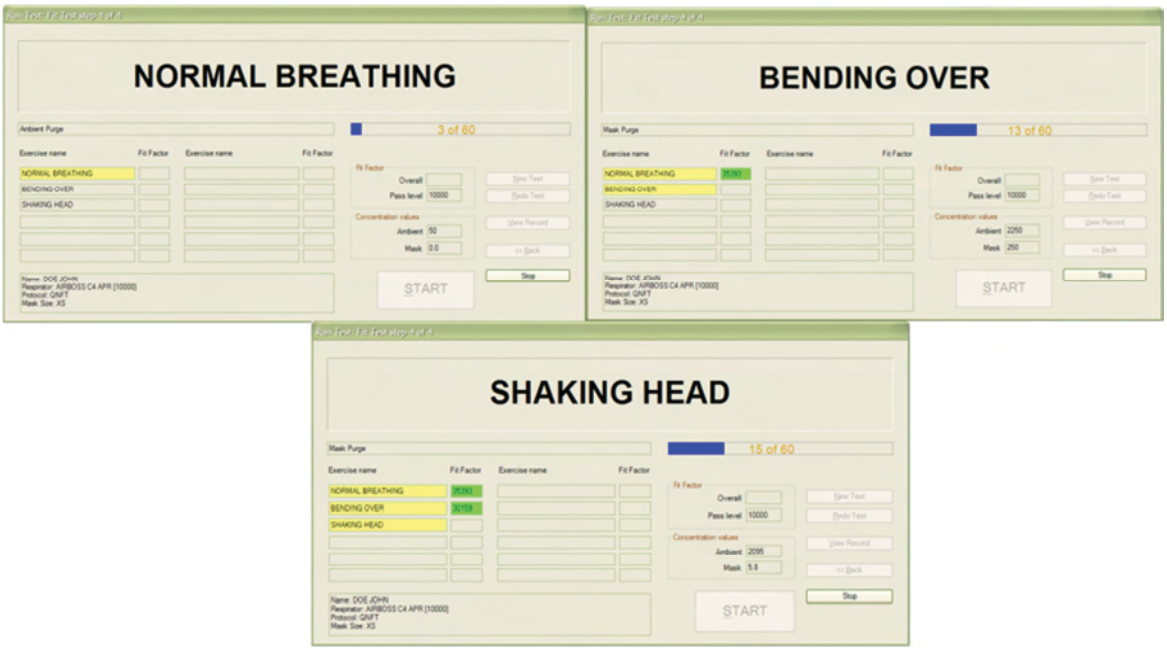

Figure 67: Example of a QFNT activity routine

30. At the end of the activity routine, a window will open that indicates that the fit test has been completed as shown in Figure 68. The window will indicate a pass or fail for the fit test. The fit factor of each activity and for the overall activity routine will be observed. Green fields indicate acceptable fit factor values while red fields indicate failed values. It is the overall fit factor that is used to judge the test, but individual activities that fail may be used to diagnose particular issues with the respirator fit.

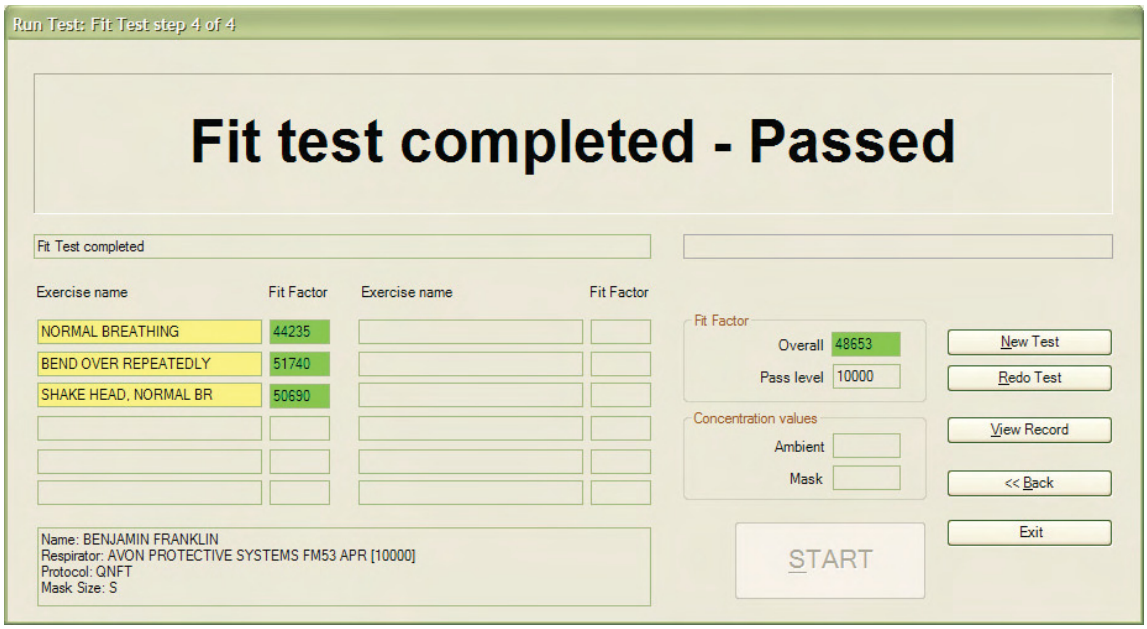

Figure 68: Completed fit test

31. Instruct the candidate to disconnect the adapter from the sampling tube and to step outside the tent enclosure (it may be preferable to wait if more than one candidate is testing at once).

32. Record fit test results and enclosure concentration onto record sheet.

33. Press “Exit” to close window.

34. Instruct candidate to properly doff the respirator if fit test passed. Once candidate has completed testing with a given respirator, replace the drinking tube straw on the respirator and remove fit-test canister.

35. If the candidate failed the fit test, perform troubleshooting techniques as outlined in the body of the document and in Annex G.

36. After fit testing has been completed for all required people export fit test data from the FitPro™ software (Annex F.2).

37. Put a HEPA filter on the blue (ambient) tube of the twin tube assembly and press the real time icon on the main screen on FitPro™ Software (Figure 58). Select “CONCENTRATION” to observe particle count going down to zero (it may take a couple of minutes to maintain a zero reading). Run PortaCount® for a few minutes to clear out remaining particles.

38. Close FitPro™ Software

39. Switch the alcohol wick with the storage cap and put all equipment back into the case. For generator pack-up and maintenance refer to Annex A.

40. For general maintenance activities refer to Annex I.

Annex F FitPro™ software

F.1 How to program an activity routine in FitPro™ software

1. To select an activity routine to be the default protocol, to edit an existing protocol or to create a new protocol press the "edit protocol" icon as shown in Figure 69.

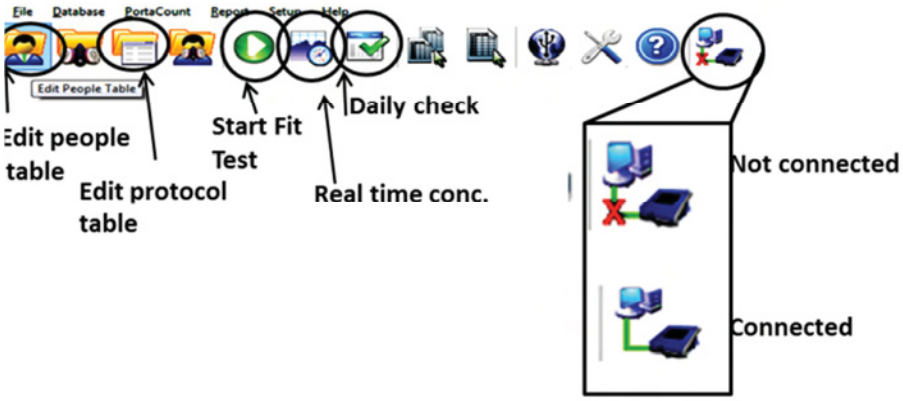

Figure 69: FITPro™ main screen

2. The "Edit Protocol Table" window (Figure 70) will open.

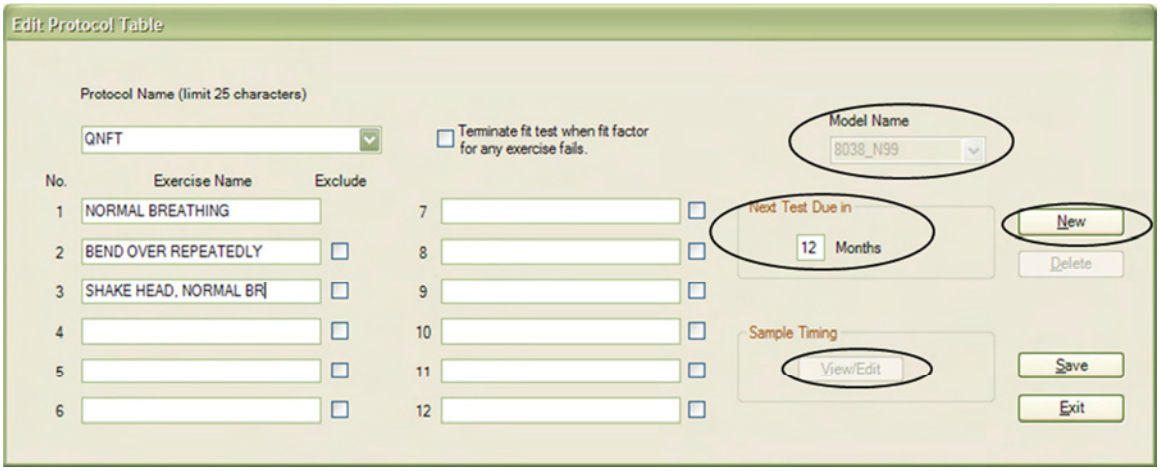

Figure 70: How to change or create a new activity routine

3. Ensure model name is correct for the PortaCount® used. Ensure appropriate retest interval is selected under "Next test due in".

F.1.1 Setting Default Protocol

1. Select the desired activity routine from the drop-down menu (Figure 70) and press "Save".
2. A window to make the selected protocol the default protocol will appear as shown in Figure 71.

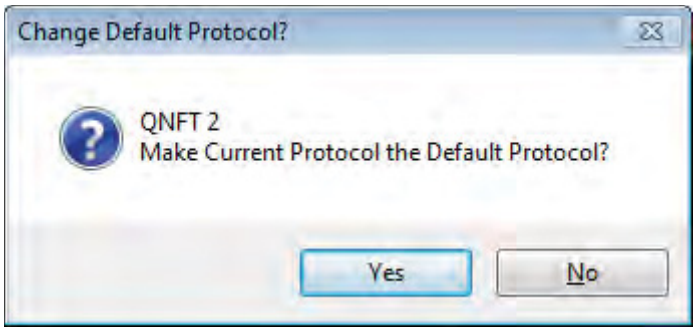

Figure 71: Changing of default protocol setting

3. Select "Yes". The selected protocol will be the default protocol used for the upcoming fit testing.

F.1.2 Editing a Protocol

1. To edit an existing protocol, select the protocol from the drop down menu (Figure 70). Enter all activities to be performed during the routine.

2. Select "View/Edit" under "Sample Timing" to view or set sample timing (Figure 72).

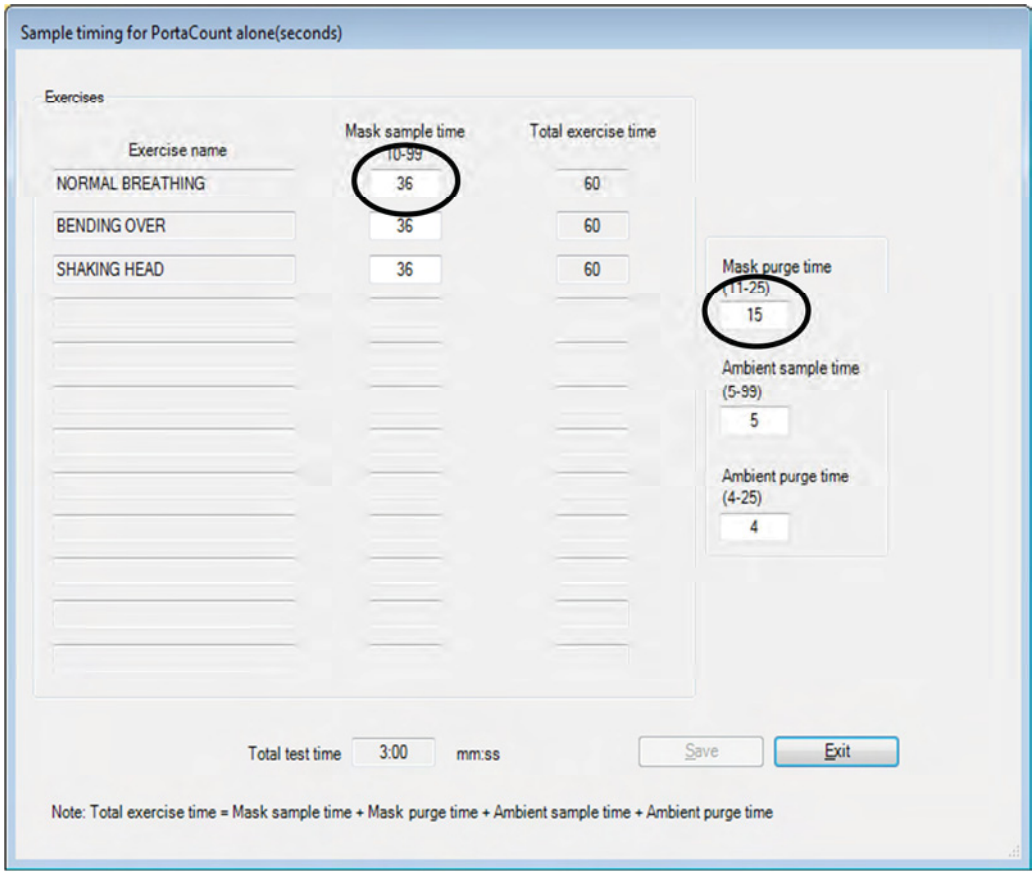

Figure 72: Sample Timing Window

3. Confirm that mask purge time is 15 seconds, and mask sample time for each activity is 30 seconds. Ambient sample is 5 seconds and ambient purge is 10 seconds.

4. Select “Save”, then “Exit”.

5. Select “Save” on the “Edit Protocol Table”. A window to make the new protocol the default protocol will appear as shown in Figure 71.

6. Depending on your preference, select “Yes” or “No”. Select “Yes” if protocol is to be used during the upcoming testing.

F.1.3 Creating a New Protocol

1. Select “New” button to create a new activity routine (Figure 70), insert a name for the protocol under “Protocol Name”.

2. Enter all activities to be performed during the routine.

3. Select “Save” and a window to make the new protocol the default protocol will appear. Select “View/Edit” button to view and set sample timing (Figure 72).

4. Set mask purge time to 15 seconds, and mask sample time for every activity to 30 seconds. Ambient sample is 5 seconds and ambient purge is 10 seconds.

5. Select “Save” and “Exit” button to save the sample timing.

6. Select “Save” on the “Edit Protocol Table”. A window to make the new protocol the default protocol will appear as shown in Figure 71.

7. Depending on your preference, select “Yes” or “No”. Select “Yes” if protocol is to be used during the upcoming testing.

8. Select “Exit” on protocol table to exit protocol table.

F.2 Export of Fit test data in FitPro™ software

F.2.1 Excel

1. To export data from the currently active database in excel format go to main screen (Figure 69) and select “Database” tab, “Export” and then select “Excel format”.

2. Window “Export data in Excel format” will appear (Figure 73).

Figure 73: Export of data in Excel format

3. Select the "Fittest" table and also select on "Browse" to select the destination directory.

4. Name the file and press "Save".

5. Select "Export".

6. A window that the database table has been successfully exported in excel format will appear (Figure 74). Press "Ok".

Figure 74: Successful creation of the exported database in Excel format

7. Press "Exit".

F.2.2 Comma separated value (CSV) format

1. To export data from the currently active database in comma separated value (CSV) format go to main screen (Figure 69) and select on database tab (Figure 75), export and then select CSV format.

2. Window "Export data in comma separated value (*.CSV Format)" will appear.

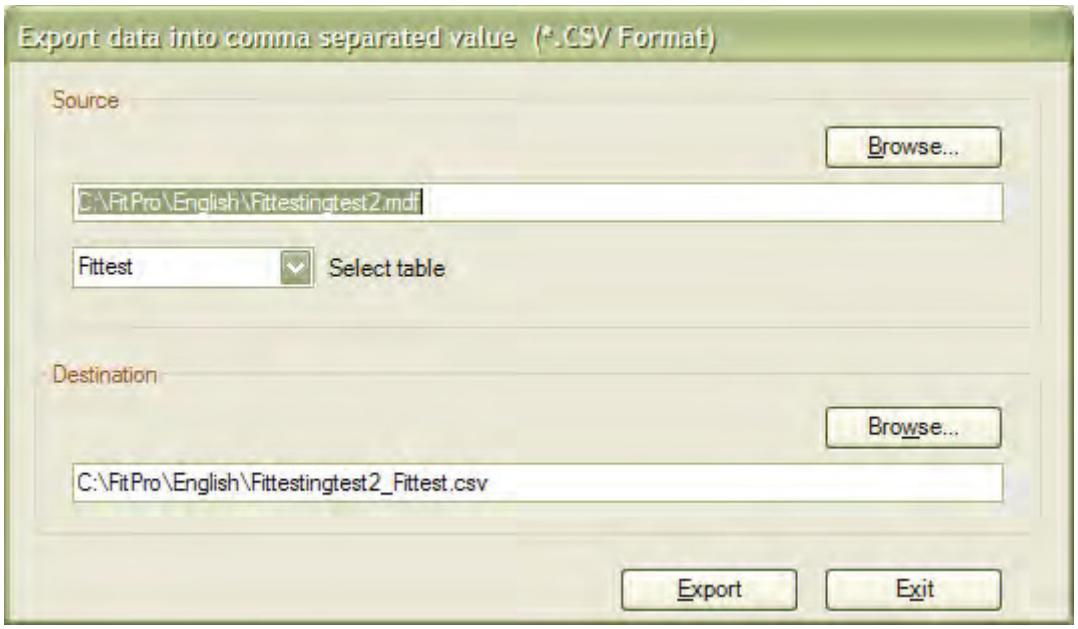

Figure 75: Export of data in comma separated value format

3. Select the "Fittest" table and also select on "Browse" to select the destination directory.

4. Name the file and press "Save".

5. Select "Export".

6. A window that the database table has been successfully exported in CSV format will appear (Figure 76). Press "OK".

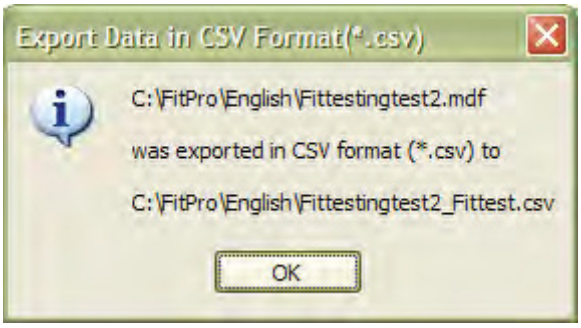

Figure 76: Successful creation of the exported database in CSV format

7. Press "Exit".

F.3 Communication of PortaCount® with FitPro™ software

To perform daily checks and fit testing the PortaCount® needs to communicate with the FitPro™ software.

1. Check last icon on the right side on the main screen (Figure 69) to ensure communication with PortaCount®. A green line connecting the PortaCount® to the laptop indicates the connection is

maintained. An X on the green line indicates no connection between the PortaCount® and the computer, as shown in Figure 69.

2. If PortaCount® does not communicate with the computer select the fourth icon from the right on the FitPro™ main screen (Configure Port Icon).

3. "Select Address" window will appear as in Figure 77.

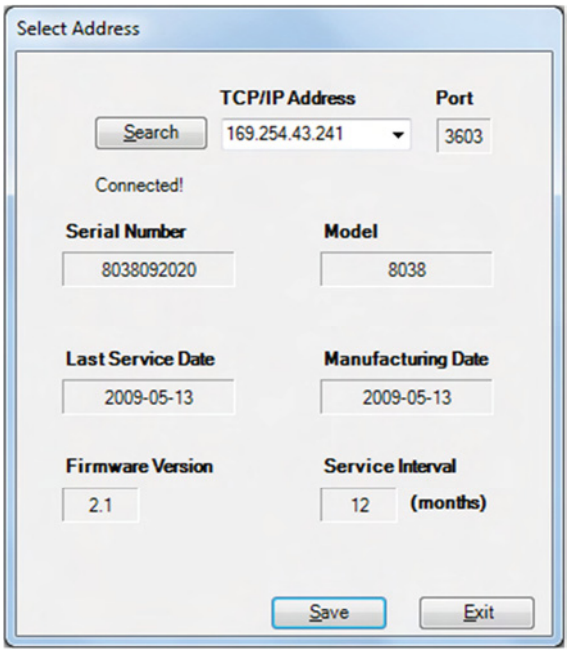

Figure 77: Select address of PortaCount®

4. The IP address should automatically appear in the TCP/IP Address field. If it does not appear, select "Search" to bring the address up.

5. Select "Save", and then "Exit".

6. There should now be a green line connecting the PortaCount® and computer in the upper right icon on the FitPro main screen.

F.4 Editing the people table

The people to be fit tested can be entered into the "People Table" before fit testing is performed.

1. Select the "Edit People Table" icon located on the main FitPro™ screen (Figure 69).

2. The Edit People Table will appear. Select "Configuration" to adjust user configuration settings (Figure 78).

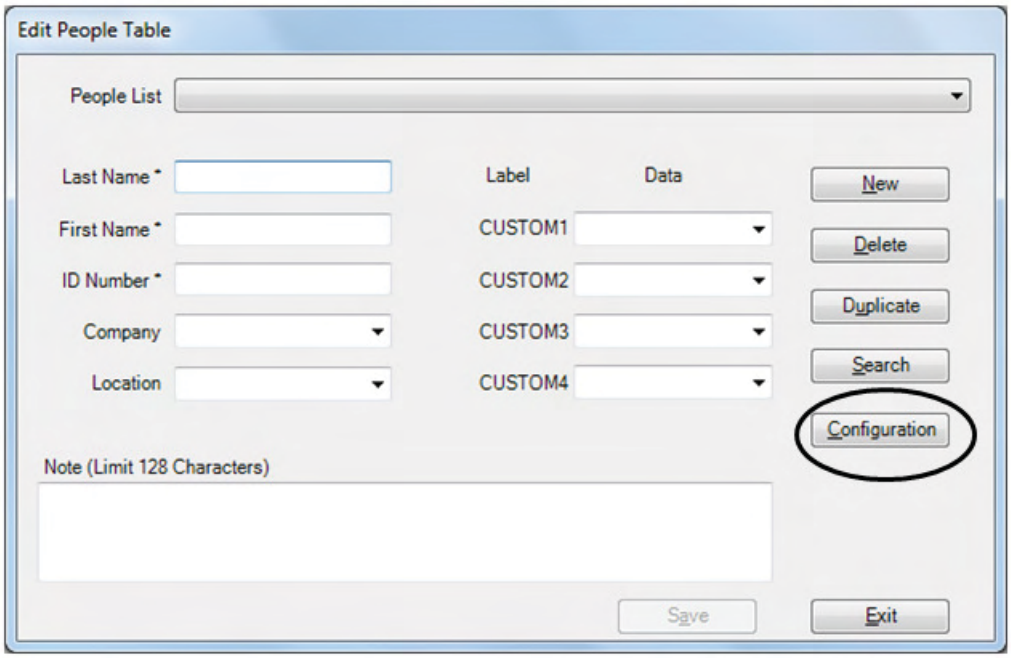

Figure 78: Edit People Table

3. A new window "User Configuration" will appear (Figure 79). The custom fields 1-4 can be used as labels shown in edit people table to insert environmental conditions (temperature, relative humidity) and worn PPE during the quantitative integration fit testing.

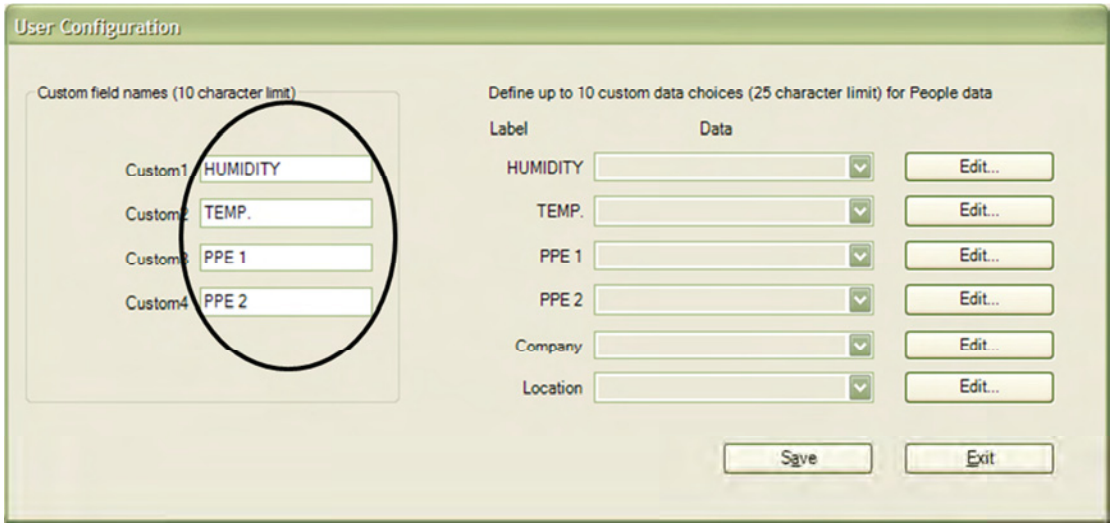

Figure 79: User configuration window

4. Replace text on left hand side beside Custom 1-4 with desired name for labels.

5. Select "Edit" beside each custom-named label on the right side to add a list of desired items, if appropriate (e.g. for PPE). A window shown in Figure 80 will appear.

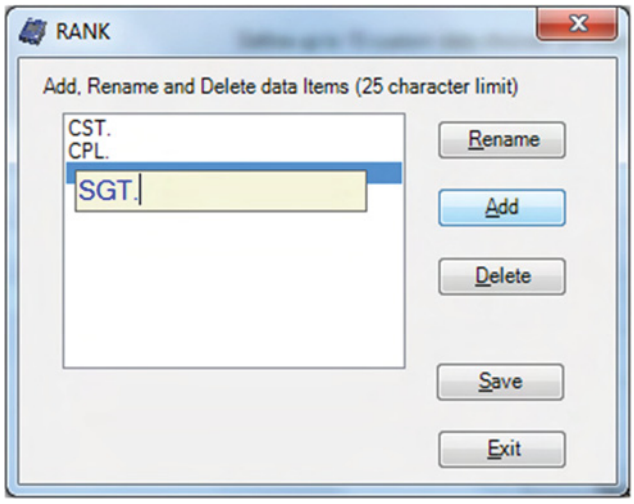

Figure 80: Edit of a custom label

6. Select “Add” to enter an item in the list of the selected label. Repeat as often as desired.
7. Select “Save” and “Exit” to go back to the user configuration window.
8. Repeat with other labels if desired.
9. Select “Save” and then “Exit” to return to the edit people table.
10. To insert a new person to the list select “New” (Figure 81).

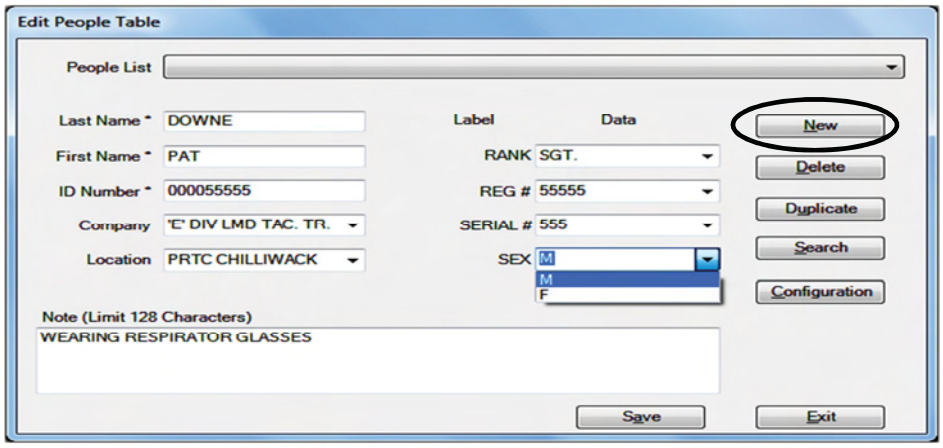

Figure 81: Creating a new list of people

11. Insert Last Name, First Name, ID Number, Company if desired, Location if desired, and labels if desired for the new person.
12. Once all information has been entered, select “Save”.
13. To enter more new people repeat steps 10 to 12.
14. Select “Exit” to close edit people table and return to main FitPro™ screen.

F.5 Editing the protocol table

1. Select “Database” from the tool bar menu (Figure 69).
2. Then select “Edit”.
3. Now select “Protocol Table”.
4. Ensure that the scroll box in the upper right titled ‘Model Name’ has the proper model selected. For this purpose it should say ‘8038_N99’ (Figure 70).
5. Select the “New” button (Figure 70).
6. Proceed to fill in the blank fields with your desired activity routine. There is a maximum of 12 exercises that can be a part of the protocol. In the upper left corner enter a name for this particular protocol.
7. Upon completion of this step select the “Save” button.
8. Before you exit, select on the “View/Edit” button, located beneath the heading “Sample Timing” (Figure 70).
9. Ensure that the following parameters are correct:
    a. mask sample time for each exercise is 40 s,
    b. mask purge time is 11 s,
    c. ambient sample time is 5 s, and
    d. ambient purge time is 4 s.
10. If any of these values are incorrect change them and select the “Save” button (Figure 71).
11. Select the “Exit” button.
12. Select the “Exit” button once more.

F.6 Editing the respirator table

1. Select “Database” from the tool bar menu (Figure 69).
2. Then select “Edit”.
3. Now select “Respirator Table”.
4. Select the “New” button to enter information regarding the respirator type to be tested (Figure 82).

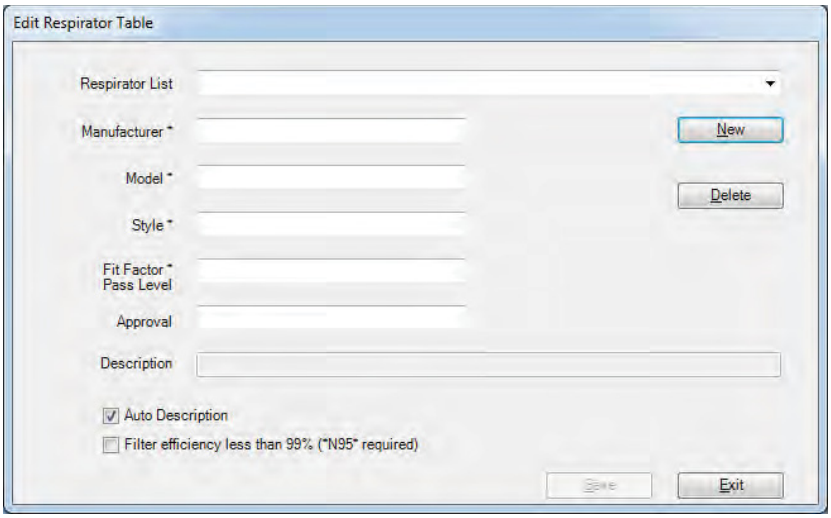

Figure 82: Edit Respirator Table

5. Proceed to enter the respirator information into the appropriate fields. (Should you wish to record more information than that requested in the blank fields, simply un-select the box labeled 'Auto Description' and proceed to enter your information into the "Description" field.)

6. IMPORTANT (re: model 8038) – Ensure that the box labeled 'Filter Efficiency Less Than 99% (*N95* required)' is NOT selected.

7. Select the "Save" button.

8. Select the "Exit" button.

F.7 Exporting database to a flash drive

1. Insert flash drive into USB port of the computer.

2. Select "Database" from the tool bar menu.

3. Then select "Flash Drive Database Exchange".

4. On the right hand side, in the top scroll menu, should be your active database. If it is not select the "Browse" button and then select the desired database to transfer.

5. In the second scroll menu you will have to create a destination database for it to be exported to if one is not already created. Simply input a name into the field in the following format: E:\YOURTITLE.xml.

6. Select "Export Database to Flash Drive" button.

7. A window will pop up informing you that the database has been successfully exported to the given file. Select "OK". (NOTE: Occasionally a message will appear indicating that the exchange failed. Simply select "OK" to this message and then the successful message will pop up. Not sure why this happens sometimes, but the database always is exported successfully.)

8. Select the "Exit" button.

F.8 Importing database from a flash drive:

1. Insert flash drive into USB port of the computer.
2. Select “Database” from the tool bar menu (Figure 69).
3. Then select “Flash Drive Database Exchange”.
4. On the left hand side, in the top scroll menu, select your database to import by selecting the “Browse” button.
5. Use the “Browse” button or the lower scroll bar to select your destination database for the information to be imported to.
6. Select the “Import Database from Flash Drive” button.
7. A window will pop up indicating that the import of the database was successful. Select “OK”.
8. Select the ‘Exit’ button.

F.9 View and print fit test records

1. Select “Report” from the tool bar menu (Figure 69).
2. Then select “Select Report”.
3. Now select on “Fit Test Report”.
4. Now choose “View Report”.
5. You may now scroll through all saved fit test reports in this particular database. You may also print if necessary one or all by choosing the “Print” or “Print All” options.

Annex G Troubleshooting of fit testing and equipment

G.1 Problems with fit test

The following issues should be considered when fit testing failures are observed. Some may be equipment issues that in some cases can be resolved by referring to the next section.

1. As the wearer ages, they may require a smaller size full-face respirator; aged skin has less elasticity and pliability to form to the mask.
2. If a person has a long narrow face and requires a smaller size full-face respirator, the nose-cup area may be found to be uncomfortable.
3. Exchange the nose-cup for a larger nose-cup if available. This will provide additional space in the nose region for a more comfortable fit.
4. Trouble with the drink tube adapter is indicated by the adapter falling off the mask during testing or a PF of 999,000.
5. A PF 999,000 indicates that the adapter is not holding the one way valve inside the drinking tube open and is sampling in a very small area inside the adapter.

    a. This can be corrected by re-attaching the adapter and ensuring a proper connection.

    b. If the adapter falls off simply reattach to the mask making sure to hear the select, and watch for further problems.

    c. Alternatively, replace the adapter with a dry one and blow out the used one with a can of compressed air and allow to sit aside to completely dry.

6. Drinking Tube must be blown out to ensure that there is no water in the tube.
7. Remove the drinking straw inside and have the person put in pocket until the testing is completed. This ensures that they don't have it in their mouth during the testing.
8. Check that beard growth and hair-lines are not interfering with the mask seal.
9. Check that buns or other bulky hair features are not interfering with the mask harness seating.

G.2 Problems with equipment

The most common problems experienced with fit test equipment and their possible solutions are detailed in Table 3, below. Additional information can be found in the Troubleshooting and Maintenance sections of the PortaCount® manual.

Table 3: Troubleshooting-common problems with fit test equipment

Problem	Possible Causes	Solutions
Ambient particle count is low [but not near zero; see below]	Tent/fit test chamber is leaking	- Check / reinforce seals and door flap. - Add another particle generator to offset uncontrolled dilution with air from outside the tent.
	Particle generator is not running	-Check power source(s); turn on generator -Check reservoir (refill if dry)
	Particle generator is clogged	-Run with fresh water for up to 2 hours. -Clean the atomizer head (refer to Annex A) -Use compressed air to blow out salt from louvers at the back of the generator. Blow air into the bottom of the generator through cooling louvers. [To minimize clogging, run the generator for 40 seconds without the reservoir at the end of each use and/or run briefly with clean water]
	Salt solution reservoir is empty, low, or salt was never added or mixed properly	-Mix a new batch of solution and fill the reservoir.
	Particle generator pressure is set too low	-Adjust to a higher setting (with a clockwise rotation of the output screw located on top of the unit)
	Compressor isn't working (red light comes on okay)	-Return to manufacturer for servicing.
	PortaCount® problem	-Perform the daily checks. [If these pass, the problem is likely elsewhere] -Confirm the ambient particle count with another PortaCount®
	Moisture in the sample tube has been sucked into the PortaCount®	-Replace or blow out the sample tube with compressed air, and: -Perform PortaCount® nozzle cleaning procedures (see Procedures A & B, below), or: -Remove alcohol wick, replace with storage cap and run PortaCount® 2 hours to dry optics
Ambient particle count near zero	Alcohol level is low	-Soak alcohol wick in the alcohol fill capsule for at least 2 minutes.
	Sampling through HEPA filter	-Remove filter
	Twin Tube Assembly is blocked	-Remove blockage (which may include a faulty drinking tube adapter; see final row)
	Moisture build-up in	-Change alcohol wick inside cartridge.

Problem	Possible Causes	Solutions
	alcohol wick or contaminated alcohol	-Also remove alcohol wick from PortaCount®, replace with storage cap and run PortaCount® 2 hours to dry optics. [If necessary, based on a lack of available replacement parts, extend the life of the wick by drying it out and then re-soaking in alcohol. Drying can be accomplished by leaving the cartridge in a running PortaCount® overnight, or by removing the wick from the cartridge and air drying for 48 hours.]
	PortaCount® is flooded with alcohol	-Remove alcohol wick, replace with storage cap and run PortaCount® 2 hours to dry optics.
	Filter cover is leaking	-Replace cover and O-ring.
	Plugged nozzle	-Clean the nozzle [located at far end of wick cavity; it cannot be seen]: Procedure A -Turn off PortaCount® and remove alcohol cartridge from PortaCount® cavity. -Insert long extension nozzle of compressed gas can down the centre of the cavity, gently pushing as far as possible. -Apply 2 or 3 bursts of gas (this will not cause any damage). -Reinsert alcohol cartridge and run daily checks. If problem persists try procedure B. Procedure B -Turn off PortaCount® and remove alcohol cartridge from PortaCount cavity -Tip PortaCount® on its end so that you can look down the cavity. -Drip max of 3 to 4 drops PortaCount® alcohol down the centre without hitting the sides (1 drop is enough if it all reaches the nozzle) -Keep PortaCount® tipped up for 5 minutes while the alcohol softens/dissolves blockage. -Set the PortaCount® down to the normal horizontal position and repeat Procedure A.
Large number of QNFT failures.	PortaCount® malfunction	-Perform daily checks. -Compare to another PortaCount®. -Review other PortaCount® troubleshooting information (above and in PortaCount® manual)
	Particulate contamination	-Confirm canisters being used are low dust and have high particulate filtration efficiency (99.997%) -Check for leaks in the system, e.g. the alcohol cartridge may not be tightly inserted or there may be a missing O-ring. Check for a split sample tubing or poor connection to drinking tube or probe. [If test candidates are smokers, ensure at least 30 minutes has elapsed (and up to 2 hours) between smoking and the QNFT]

Problem	Possible Causes	Solutions
PortaCount® displays a PF higher than the max. fit factor observed during the daily check (e.g. 999,000)	A near perfect respirator fit?	-Crack the seal of the respirator and check for a corresponding increase in particles. -If not, check connector.

Annex H PortaCount® Model 8020 maintenance

H.1 Procedure

1. Remove the storage cap.
2. Apply a few drops of isopropanol to the bottom of the inside of cartridge cavity and blow out with compressed air.
3. Place PortaCount® upside down (screen-side down).
4. Using a Philips screwdriver, remove the four screws around the outside of the device (Figure 83).

Figure 83: Removal of screws that hold case together

5. Rotate device to the upright position.
6. Carefully remove top cover. Unplug the ribbon cable as shown in Figure 84.

Figure 84: Removal of top cover

7. Check all tubes for water or other residue buildup. If a tube has buildup in it, clean with alcohol and compressed air.
8. Remove screws on sampling cone using 7/64 hex key (Figure 85).

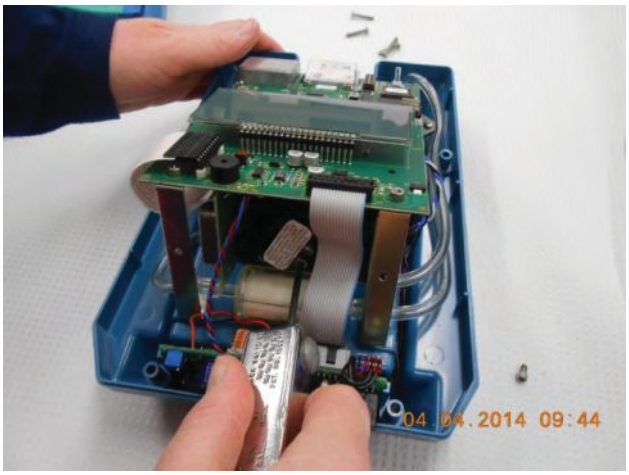

Figure 85: Removal of sampling cone screws

9. Remove sampling cone from device. Note that the sampling cone is difficult to access and that a flathead screwdriver may be required to remove the cone from the device (Figure 86).

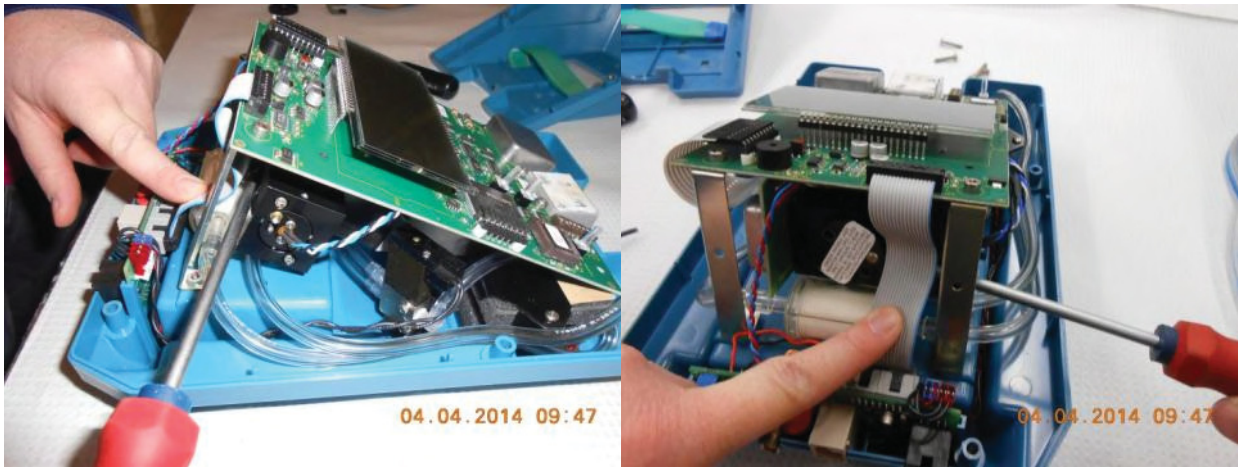

Figure 86: Removal of sampling cone

10. Clean sampling cone with isopropanol soaked cotton swab or KimWipes™, and then blow with compressed air (Figure 87).

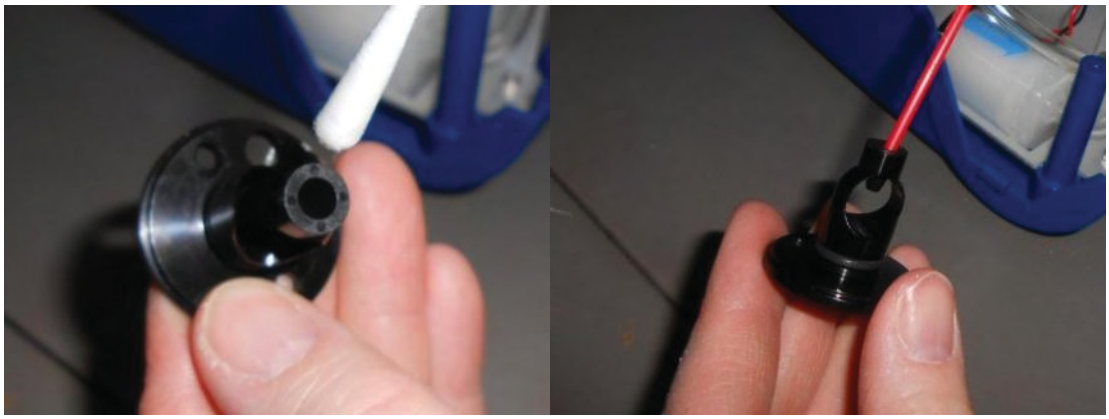

Figure 87: Cleaning of sampling cone

11. Return sampling cone to PortaCount® and install screws.
12. Remove screws on main circuit board using 7/64 hex key (Figure 88).

Figure 88: Removal of circuit board screws

13. Shift circuit board to the side so that the switching valve is accessible (Figure 89).

Figure 89: Repositioning of circuit board

14. Remove screws from switching valve using Philips screwdriver.
15. Carefully remove switching valve from place (Figure 90).

Figure 90: Disconnecting switching valve

16. Clean contact point between switching valve and device using isopropanol and a cotton swab or KimWipes™. Blow the valve out with compressed air (Figure 91).

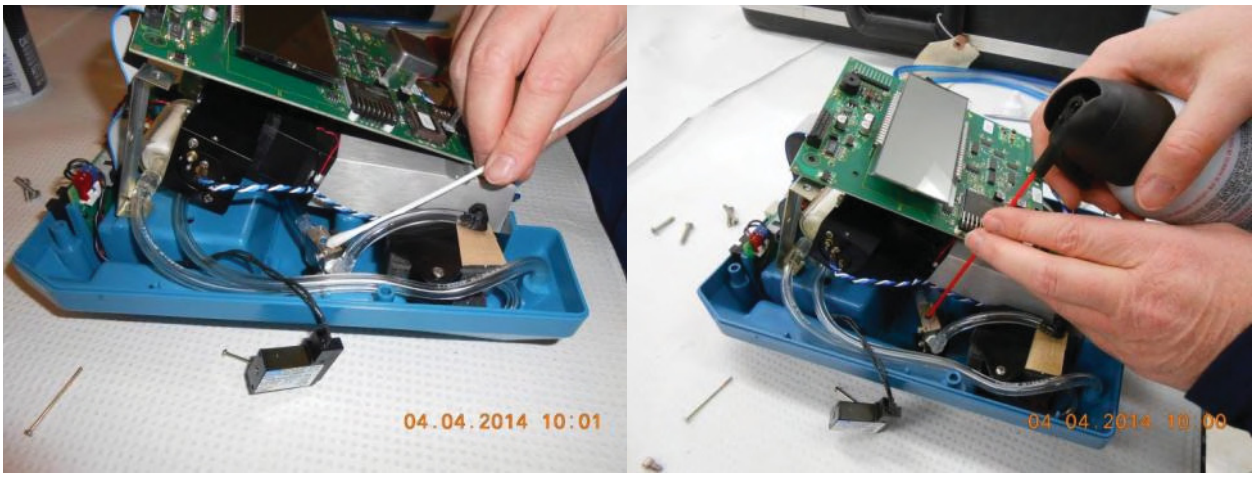

Figure 91: Cleaning of valve contact

17. Replace switching valve and re-insert screws.

18. Replace circuit board re-insert screws.

19. Replace cover, ensuring to connect ribbon. Re-insert screws.

20. Re-insert storage cap.

H.2 Scheduled maintenance

Refer to the Maintenance Schedule for maintenance procedures and intervals for the PortaCount® Plus Particle Counter and particle generator (Table 4).

Table 4: PortaCount® 8020 Maintenance

Procedure	**Interval**
PortaCount® Plus Particle Counter	
Refreshing Alcohol Cartridge	8 hours
Replacing the wick	After decolourization or if saturated with water/dirt
Clean Lint Filter	Daily
Clean Nozzle with Air	Daily
Clean Valve	Daily
Clean Nozzle with Water	3 Days
Recalibration Interval	Annually
Particle Generator	
Mixing salt solution	Daily
Run with Clean water	Daily
Cleaning the Atomizer jet	As required
Tent/Enclosure	
Clean windows with Moist Cloth	As required

Annex I PortaCount® Model 8030/8038 maintenance

I.1 Procedure

1. Remove storage cap and unscrew inlet sampling ports as in Figure 92.

Figure 92: Removal of wick cap and inlet sampling ports

2. Place PortaCount® upside down (screen-side down).

3. Use an extended 3/32 inch hex key to remove four screws located on the bottom of the PortaCount® (Figure 93).

Figure 93: Removal of hex screws

4. Rotate device to upright position.

5. Remove side panels and lift lid (Figure 94).

Figure 94: Lifting lid

6. Unplug ribbon cable and set lid down behind device. Ensure no wires become loose (Figure 95).

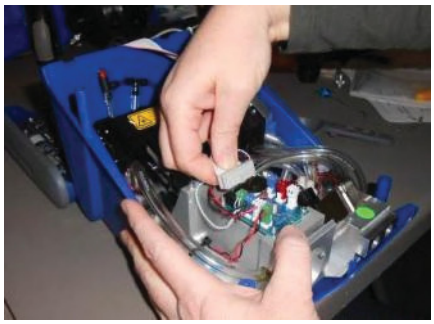

Figure 95: Unplugging ribbon

7. Remove the screens from the sampling port and check for salt accumulation. To remove salt, soak the filters in warm water and blow with compressed air (Figure 96).

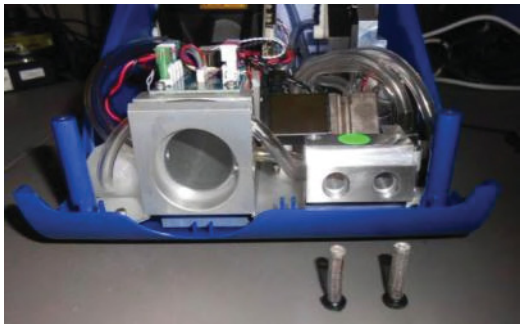

Figure 96: Removal of sampling port screens

8. Lift switching valve and clean holes in bottom of valve and inside the panel. Clean with an isopropanol soaked cotton swab or KimWipes™ then blow with compressed air (Figure 97).

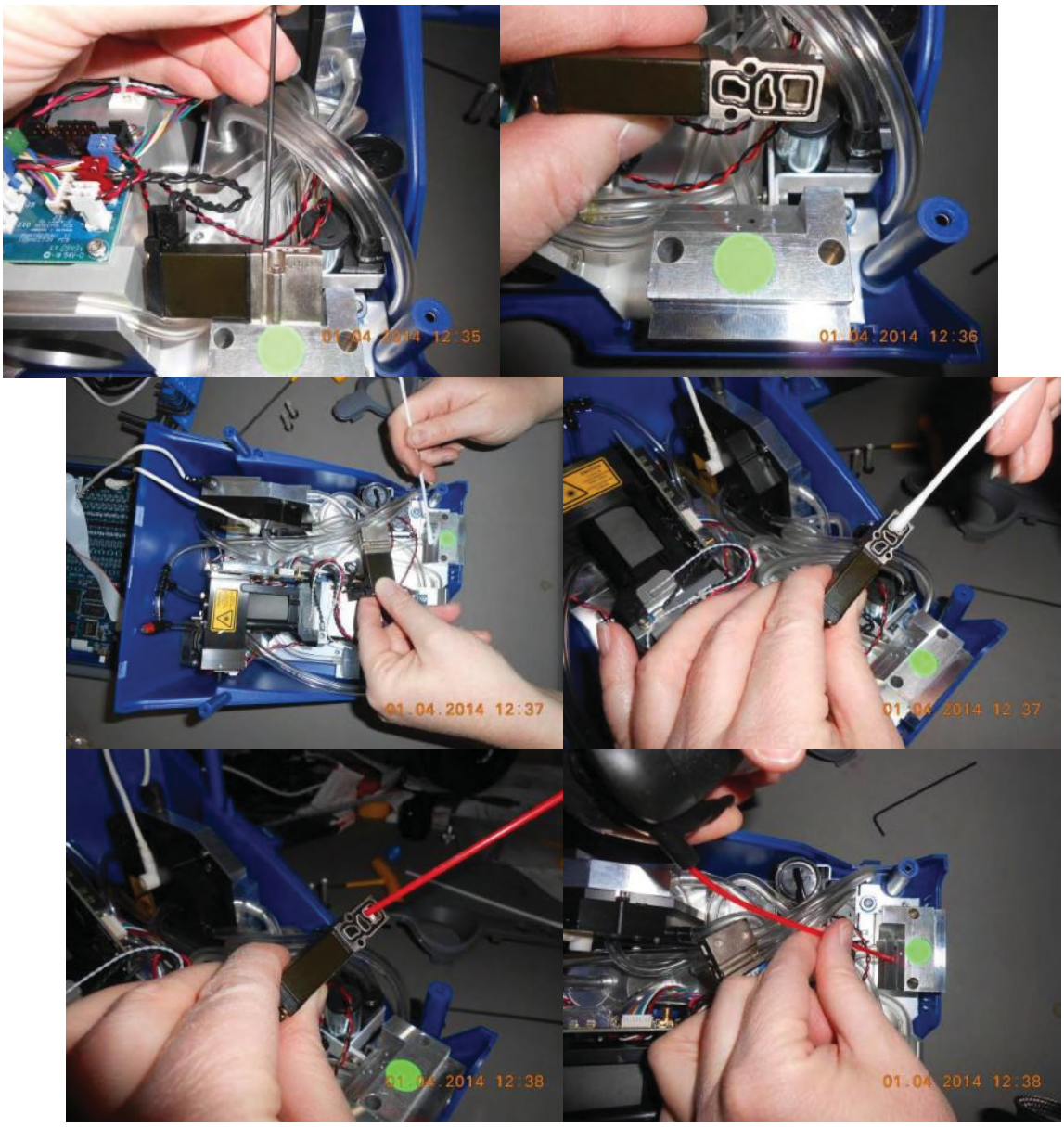

Figure 97: Cleaning of switching valves

9. Use a short 3/32 hex key to carefully remove two screws from the laser box (Figure 98).

Figure 98: Cleaning of switching valves

10. Use thumbs to lift sampling cone from laser box (Figure 99).

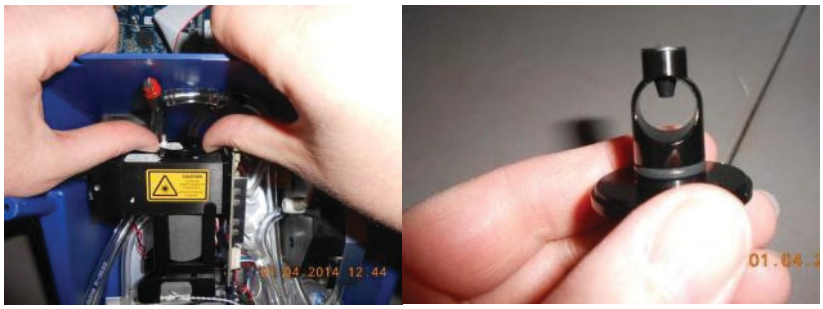

Figure 99: Removing sampling cone

11. Clean with an isopropanol soaked cotton swab or KimWipes™ then blow with compressed air.
12. Return sampling cone to PortaCount® and install screws.
13. Blow cooling fan with compressed air. Make sure to lift lid while blowing to ensure does not deposit in the lid.
14. Replace front console and attach ribbon cable.
15. Replace lid.
16. Invert PortaCount® and re-insert hex screws. Tighten.
17. Re-insert wick cap and sampling ports.

I.2 Scheduled maintenance

Refer to the Maintenance Schedule for maintenance procedures and intervals for the PortaCount® Pro Particle Counter and particle generator (Table 5).

Table 5: 8030/8038 maintenance

Procedure	**Interval**
Particle Counter	
Refreshing Alcohol Cartridge	4 hours
Replacing the wick	Daily
Clean Lint Filter	Daily
Clean Nozzle with Air	Daily
Clean Valve	Daily
Clean Nozzle with Water	3 Days
Recalibration Interval	Annually
Particle generator	
Mixing salt solution	Daily
Run with Clean water	Daily
Cleaning the Atomizer jet	As required
Tent/Enclosure	
Clean windows with Moist Cloth	As required

List of Symbols/Abbreviations/Acronyms/Initialisms

Airboss	Airboss Defense: A PPE manufacturer
APR	Air-purifying respirator
Avon	Avon Protection: A PPE manufacturer
C4	In-service Canadian Armed Forces respirator manufactured by Airboss
C50	First responder respirator manufactured by Avon Protection
CF/CAF	Canadian Armed Forces
CAN	Canadian, used to refer to a national standard
CBRN	Chemical, biological, radiological, and nuclear
CFMLT	Canadian Forces Maintenance Leak Tester
CGSB	Canadian General Standards Board: a standards development organisation
ChemTape®	Chemical resistant tape sold by Kappler
CNC	Condensation nucleus counter
CRTI	CBRN Research and Technology Initiative
CSA	Canadian Standards Association: a standards development organisation
DND	Department of National Defence
DPE	Dermal Protective Ensemble
FitPlus/FitPlus™/FitPlus3	TSI PortaCount™ fit testing software for Model 8020
FitPro/FitPro™	TSI PortaCount™ fit testing software for Model 8038
FR	First responder
HEPA	High efficiency particulate aerosol
ISQ	Individual system qualification
KimWipe™	Kimberly-Clark® KimWipes: cleaning tissue sold by Kimberly-Clark Corporation
MITA	Mask Integrity Test Accessory
MSA	Mine Safety Appliances
N95	A filter medium that removes at least 95% of NaCl airborne particles ~0.3 µm in mass median diameter. Note: N95 is a National Institute for Occupational Safety and Health (NIOSH) filter designation in accordance with 42 CFR 84.
PAPR	Powered air-purifying respirator
Particle generator	TSI particle generator Model 8026
PC	PortaCount®: a CNC device used for fit testing
PC4	First responder version of the C4
PF	Protection factor
PortaCount®	TSI PortaCount® model 8020/8030/8038 particle counting instrument
PPE	Personal protective equipment
QLFT	Qualitative fit test
QLIFT	Qualitative integration fit test
QNFT	Quantitative fit test
QNIFT	Quantitative integration fit test

RCMP	Royal Canadian Mounted Police
RMC, RMCC	Royal Military College of Canada
RPD	Respiratory protection device
RPP	Respiratory protection program
SCBA	Self-contained breathing apparatus
SOP	Standard operating procedure
TSI	A company that produces instrumentation focussed on particulate monitoring
Z94.4	A CSA respiratory protection standard for occupational health
Z1610	A CSA CBRN PPE standard